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PRESENT STATUS OF EYE EXERCISES FOR IMPROVEMENT OF VISUAL FUNCTION

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One of the fundamental laws of biology is that repetition of an act facilitates its performance. The first time one does something one may do it clumsily and laboriously; the hundredth time it may be done dextrously and with ease. No principle of physiology and psychology is more firmly established than this. It is, of course, the basis of acquiring skill in any performance. To understand its modus operandi one must recall the way the nervous system is organized and how it operates. There are a prodigious number of nerve cells and an intricate network of communicating fibers. These fibers afford pathways for messages—nerve impulses—from one "center," or group of nerve cells to another and, finally, to a muscle or gland or other effector, unless somewhere along its course the impulse is arrested by inhibitory forces. When an act is clumsily performed, the messages are not passing smoothly and freely along the proper pathways; false turnings must be corrected before the desired end is reached. If the act is repeated over and over again, the passage of the nerve currents in the proper pathways is made easier and more efficient, i. e., with fewer false turns or hesitations —is "facilitated" as it is called.[1]

Repetition is the essential feature of exercises, training and learning, as these terms are used here. Obviously, repetition of an act with a faulty method will serve to confirm the fault just as surely as repetition with a correct method will confirm the good habit. This is why the capable coach or trainer or teacher watches early for faulty performance. For instance, the golfer who practices his swing in a faulty way only confirms his faults; he will improve and, if he has some natural talent, may consistently get below 100; but unless he has a competent teacher, he cannot expect to break 80 except by a rare streak of luck; his play will be erratic and uncertain.

So in orthoptics, for example in bar reading, the more the patient reads in the wrong way, shifting his fixation from eye to eye, so swiftly perhaps that he reads aloud smoothly line after line, the more deeply rooted does his suppression become. The experienced orthoptist could cite many other examples of ways in which exercises, perhaps with automatic electric motor contrivances, cause the patient to make certain movements but do not guard against his carrying them out by a faulty method.

If the act involves muscular performance, as most acts do, the muscles involved increase in size and power (hypertrophy) and become stronger. If the muscles are already strong enough, no increase results from the exercise. For example, in learning to row two things are involved, skill in handling the oars and muscles strong enough to do the work required.

There are many activities which call for increased strength of the muscles, as well as increased skill in using them. This is notably the case if the learning of a given skill is undertaken before the person has reached full muscular development. If a boy of 12 takes up golf, he can learn to swing the clubs with great skill and graceful coordination; but until his muscles become stronger, he cannot strike the ball hard enough to make a long drive. So the man who is strong—has plenty of muscle—will say that the secret of a long drive is the skill and coordination ("timing" he may call it) used; the weak-muscled player will say it is the power one can put into it that makes the ball go a long way. In fact, of course, both skill and power are essential. In faulty ocular movements such as convergence insufficiency, there are still many who think it is strength of muscular power that is lacking.

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1. This statement simplifies too much the matter of learning. The result would be rigidity, lack of flexibility. If repetition, by facilitating the passage of messages along a fixed route, were the whole story, how could one account for the important fact that when one has learned how to do something, one is able to adapt the performance to unexpected variations in conditions which may arise and may call for immediate changes in the way the act is best performed in some of its details?

Others, realizing the great excess of muscular strength that is provided in the ocular muscles, stress the lack of coordination, the inability to use the muscles, the lack of "skill," employing that word in a broad sense.

That exercise and practice improve the performance of muscular, or motor, activities no one is likely to deny. In the case of sensory activities there may be certain doubts. How, one might ask, will practice improve sight or hearing? The dioptric images formed on the retina serve as the stimulus; the only way to improve sight is to get a better image on the retina. This cannot be obtained by practice or exercises. This concept of seeing is far from correct. The first step in seeing is the formation of a good image on the retina, by fixation on the best part of the retina, the fovea; but this is only the first step.

It is well established that it is impossible to experience a pure, isolated sensation. There are two factors which affect all sensations as they reach consciousness and become perceptions. The first is concerned with all the other sensations coming into consciousness at the same time through the visual apparatus, and not merely through the visual apparatus but through tactile, kinesthetic, auditory and all other avenues.

The second factor comprises memories of past experiences, and even inherited predispositions. I wish there were time to elaborate on this phase because it is of enormous practical importance in an understanding of how one sees. It explains how a mere glimpse, perhaps in dim light, of an object well known from previous experience, results in one's "seeing" many details which, as a matter of fact, are supplied by memory. For example, the apparent color of a dress may be altered by the color of the lighting under which it is seen, but because one knows from many past experiences what the color is under daylight (white light), the object is "seen" as having its well known, not its apparent, color.[2] So, in even greater degree with apparent size, apparent distance and apparent form, the pattern as a whole is appreciated as a unitary and complete pattern, without any conscious analysis of its individual details. Different stimuli, often apparently contradictory, may produce the same response. A square card seen obliquely makes an image on the retina which is not square, but it is "seen" as square, from whatever angle it is viewed. "The essential factor, therefore, in the emergence of any pattern is its meaning."[3] I must assume that the reader is thoroughly familiar with these facts, about which volumes have been written.

The memories of past experiences (usually unconscious) affect profoundly the various sensations. It is obvious that exercises and practice serve to build a substratum of experience, a storehouse of memories, which facilitate perception of whatever is the subject of the practice and exercises.

The effects of exercises which I wish to stress are as follows:

1. The facilitation of pathways and of conditioned reflexes.

2. The accumulation of a fund of experiences, a storehouse of memories and associations, from which are evoked responses by the immediate sensations, which lead to interpretations and which altogether build up and determine the perception. In short, seeing is only half ocular; the other half is cerebral. One cannot say that either half is the more important, since the two are equally indispensable and in practice inseparable.

An effect which I wish not to stress, but to minimize, is the increase in muscular strength which results from exercise.

Examples of the effect on sight of practice or exercises follow:

1. Treatment for color blindness in men rejected from military service. The usual procedure, called the light and filter treatment, as described by optometrists, consists in the fixation of colored sources of light for several minutes and the use of filters, with a daily check of progress on the pseudoisochromatic plates.

Two instructors in optometry at Ohio State University, Bridgman and Hofstitter,[4] skeptical about this method of improving color vision, tested several subjects, 3 of whom had passed the Navy tests successfully after treatments by a practicing optometrist. The authors concluded that their results did not in any way support the assumption that the exercises intended to train color vision are of any assistance. It appeared, on the contrary, that the exercises are merely time consuming and that the improvement in scoring is related only to the learning made possible by repeated testing.

A color-blind subject from the eye clinic, tested in the usual way, had a score of 15 of 46 plates in the first test. He was tested four times. He was told when he was wrong but was not given the correct answer. His scores were 27, 35, 43 on the second, third and fourth tests. Similar results were obtained with other subjects. The

2. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1933, vol. 1, p. 1019.

3. Duke-Elder,[2] p. 1023.

4. Bridgman, C. S., and Hofstitter, H. W.: Improving Color Vision, Optom. Weekly **34**:471 (May 27) 1943.

authors showed how this improvement can be explained. They concluded that those who criticize the practice of training color vision are entirely justified. They find no evidence that color filter treatment is effective in improving color blindness. They questioned the type of evidence which has been accepted as a conclusive indication of improvement in color vision. Proof of such improvement can be supplied only by measurement of fundamental color vision functions, such as the Rayleigh Equation. The treatment, they concluded, is not justified since it may lead to the acceptance of responsibilities which the patient cannot fulfil, though he erroneously believes himself cured of color blindness.

This is an excellent piece of work, such as one has learned to expect from the optometry laboratory of Glen Fry. It is to be noted that though the color blindness is not cured, the subjects do learn to see the plates more correctly, an illustration of how practice operates.

2. Peripheral vision.[5] Over 200 subjects were tested under properly controlled conditions. The evidence indicated that peripheral visual acuity can be trained. Twenty per cent of the original group of 100 subjects when retested showed improvement of 16 per cent. The improvement was roughly proportional to the amount of time taken by the test.

3. Speed with which a number of digits or letters are seen. Renshaw [6] reported work on the Polish lightning calculator Dr. Finkelstein, who memorized 8 digits in .003 second, 12 digits in 0.824 second and 16 digits in 1.73 seconds. Renshaw then took 12 university students, 2 of whom were able in time to surpass Finklestein's record. For example, after twelve practice sessions of thirty minutes each, one average student was able to memorize a 12 digit number in 1.5 seconds, although at the beginning it took him 90 seconds. A more highly trained subject memorized a 21 digit number in 4.372 seconds instead of 90 seconds, as in early trials.

Renshaw commented:

> The difference between the expert and the novice in the rapid and accurate perception of visual material is the same difference as that between the expert and the novice in the performance of any skilful act. We have to learn to see just as we have to learn to swim, to play the piano, or to speak French. This can be done with skill and efficiency, or it can be done haltingly and ineffectively. When we train children to learn to spell English words by replacing the wasteful and ineffective disjunctive method of seeing words, with the proper method of visual perception, spelling difficulties disappear. Not only does a child spell accurately and easily, but he comes to enjoy spelling. An incidental by-product also is that his rate of reading and index of comprehension automatically show a corresponding improvement.

4. An experiment in which a person with practically normal eyes wears an eikonic lens magnifying one meridian of one eye. This throws his binocular space perception out of gear but does not affect his monocular judgment of space. For a few days, especially in the morning, he is somewhat annoyed by this defect, but as time goes on he learns to suppress his faulty binocular perceptions and rely on his monocular clues. If he is placed in an environment in which monocular clues are few or absent, he is much disturbed. Since most situations present abundant monocular clues, a room for instance, he is aware of little or no effect on his seeing. He has learned to adapt himself to the new conditions.

5. Orthoptic training for heterophoria or heterotopia.

(*a*) A bookkeeper did his work laboriously and more slowly than he ought, with too many errors and with undue fatigue and frequent headaches. He had considerable heterophoria, with suppression which made it unduly difficult to follow lines across the paper correctly and to add up columns of figures. A few weeks' training by an orthoptist, with faithful home work, resulted in his learning how to use his eyes more skilfully, so that his work was made easy and rapid, with greatly reduced fatigue.

(*b*) A girl aged 12 years had accommodative convergent strabismus with hypermetropia of 3 D. and slight astigmatism. Convergence without glasses was 25 prism diopters, and with glasses, 5 prism diopters (with the eyes cosmetically straight). Her mother did not want her to wear glasses. A few months' training by an orthoptist resulted in the patient's learning to hold the eyes straight without glasses.

(*c*) A child with convergent strabismus and amblyopia of the left eye first learned to see with the amblyopic eye by occluding the right eye; he next learned simultaneous perception, then fusion, then stereoscopic depth perception on the synoptophore and, finally, good binocular vision as a habit, i. e., not merely on the synoptophore but in casual seeing.

6. True myopia. An important group of patients with true myopia and other defects earnestly desire to get rid of their glasses. They have been told by an ophthalmologist or optometrist that they must wear glasses all the time. They go to a follower of Bates who tells them to dis-

5. Low, F. N.: Studies on Peripheral Visual Acuity, Science **97**:586 (June 25) 1943.

6. Renshaw, S.: Psychology of Vision, released through the optometric extension program, Duncan, Okla., 1939 to 1942.

card their glasses, which are crutches. To their surprise, nothing serious happens! Their sight, of course, is still blurred for distant objects, but they find that by practice they acquire the ability to make out objects better through the blur than they did when they wore glasses constantly. They are apt to exaggerate this gain in talking about it.

A young man who had been wearing concave lenses asked if there was any way he could pass the test for 20/20 vision. Vision was 20/15 with glasses but was 20/30 without glasses. He was given a + 1.00 D. sphere for each eye to wear constantly for three days. His visual acuity was 20/15 without glasses and 20/15 with a + 0.50 D. sphere, and he read some letters of the 20/20 line with a + 1.00 D. sphere. Was his myopia cured? No, because he did not have myopia to begin with. He learned to relax his accommodation. He was judged to be myopic by some one because when a — 0.50 D. sphere was placed before his eye, he said, "that is better, clearer." That a young man with 20/15 vision sees better with a — 0.50 D. sphere shows that he has good accommodation, not that he has myopia. Other evidence is necessary before such a diagnosis is justified. He should read one or two lines more with the minus glass than he reads without it.

In each of the examples I have cited, the progress of the patient depended on his learning to use his eyes better. He learned to see the isochromatic plates better only by greater skill or proficiency in interpreting his visual sensations. In the first case, the sensations were no better; he was still color blind, but he had learned to make so much better use of his defective apparatus that he fooled the examiner. Another learned to see better with the peripheral portion of his retina not because the sensations were better or the retinal images better, but because he had learned by practice to perform better the cerebral processes which are an important part of seeing. The third subject learned to take in a group of figures in a small fraction of the time it required at first not because his visual sensations had improved, but because he had learned how to use them by practice, by exercises. The man who experimented with eikonic lenses became adapted to them by practice, by learning to suppress what was not to his advantage to "see" and to utilize instead what he found to be dependable, and therefore advantageous. Perhaps one might think the bookkeeper with the heterophoria derived his relief from strengthening certain weak muscles. This I stoutly deny. His muscles were not weak when he began, and they were not notably stronger when he had recovered from his disability. His bad habits had been changed to good ones by skilfully directed exercises and practice. Probably he had been suppressing, for one thing, and that certainly cannot be cured by strengthening muscles. The patient with accommodative convergent strabismus learned to use her muscles so as to hold the eyes straight by relaxing certain muscles, not by strengthening them. The seventh case is the most beautiful demonstration of all. The amblyopia was cured by exercises, by practice, by learning to see. The patient was guided skilfully through the intricacies of acquiring binocular vision, in its various stages, to a complete cure. Does any one think the secret was in strengthening certain muscles—in this case the lateral rectus muscle?

The eighth illustration shows how much can be gained in learning to see by persistent practice, even when the visual acuity is low. Here belong the patients who acquire improved speed and accuracy of recognition through practice when the question is not one of improvement in visual acuity—the sailor, the airman, the hunter, the fisherman, the prospector, all acquire by practice, i. e., by exercise, the ability to see better, though the visual acuity remains the same. The last example shows how the wearing of a concave lens can induce such a tonic contraction of the ciliary muscle as to counterfeit myopia and how the wearing of a convex lens may induce relaxation by a few days of practice in learning how to see.

I have tried to make it clear that exercises and practice are effective in learning to see better or to use the eyes better in many ways. Use is made of these principles in other branches of medicine, notably, in orthopedics, in which posture is corrected and various disabilities are relieved. Lately, the Kenny treatment for infantile paralysis has been in the limelight. It has achieved some brilliant results. The explanations given by the originator of the method have been shown by competent investigators[7] to be false, but that is not sufficient reason for abandonment of the treatment, the good points of which should be adopted.

Similar comments may be made about the Bates treatment, lately given such publicity by Huxley, by other authors and by numerous

7. Moldaver, J.: Physiopathologic Aspect of Disorders of Muscles in Infantile Paralysis, J. A. M. A. **123**:74 (Sept. 11) 1943. Watkins, A. L.; Brazier, M. A. B., and Schwab, R. S.: Concepts of Muscle Dysfunction in Poliomyelitis Based on Electromyographic Studies, ibid. **123**:188 (Sept. 25) 1943.

articles in the lay press.[8] The number and prominence of these articles are evidence that the public is interested. Several editorials and reviews have appeared in professional journals.[9] Notice was taken of the problem by the National Committee on Optics and Visual Physiology at its last meeting in June 1943. It is not surprising, therefore, that the secretary selected this subject as suitable for discussion here.

If one studies the various publications with an open mind, searching for the things which will explain why the public wants this treatment, one will be forced to admit that buried in a mass of what to ophthalmologists seem foolish gestures and performances, best defined as hocus-pocus,[10] there are sound and fruitful ideas. It is these that account for the survival and spread of the cult. It certainly is not foolish to believe that people can be taught to use their vocal organs in speaking or in singing, that they can be taught to play musical instruments, to dance, to skate and to play games, such as billiards or golf, and, as a result of teaching, can learn to perform better than they can without instruction and training. In the same way, the public argues, they should be instructed in the use of their eyes. They consult the ophthalmologist and are provided with glasses, but are given little information about the nature of their trouble or about measures which might help them to use their eyes successfully. Yet they hear of some one who went to a follower of Bates and got plenty of instruction. There are many, very many, patients who do not want to wear glasses, who would go to almost any length to escape that fate. This should be taken account of in dealing with such patients. The alternatives should be pointed out. Most of them appreciate having things explained to them. This takes time and patience, but the physician need not do the teaching himself; he can employ some one to do it for him. Thus he can be sure it is done right. The patient is given sound instruction, not mixed with hocus-pocus. The patient, of course, cannot discriminate between the pseudoscience of the partly educated followers of Bates and the sound truths of the well trained ophthalmologist.

However, it is important to point out that the hypothetic well trained ophthalmologist is often ignorant of certain phases of the art and science of which he is supposed to be master. He is apt to make the mistake of arguing that because Bates's theory of accommodation is incorrect, his whole program is unsound. The history of medicine is a long list of tentative theories later proved to be erroneous, but the facts they tried to explain remain firmly established, though the theories are swept away. Quinine cured malaria and continued to cure it, though the theories invented to account for its action were entirely erroneous. Likewise, lime juice cured scurvy, and so on.

Among the important things emphasized by Huxley are: The value of relaxation and the harm of tension; the pernicious influence of fear, e. g., fear of light, fear of blindness, fear of using the eyes; the dual nature of seeing—sensation plus interpretation equals perception—and the necessity of giving attention and treatment to the cerebral side of the function.[11] The fact that in carrying out treatment along these lines the method indulges in numbo-jumbo should not prevent one from making use of the good points concealed therein.

Then, with a sounder theoretic basis, and therefore more intelligent execution, the good results will be still more impressive. Orthoptics manages to cure certain of the conditions for which it is used by a more or less clumsy routine based on the erroneous theory that some muscle needs to be strengthened. With a more skilful technic, based on a wiser, more rational, theory, the progress is far more rapid and sure in the hands of persons who know how to apply the better methods.

SUMMARY

There is abundant evidence for the general proposition that exercises, repetition, practice

8. (*a*) Huxley, A. L.: The Art of Seeing, New York, Harper & Bros., 1942. (*b*) Bates, W. H.: Perfect Sight Without Glasses, New York, Central Fixation Publishing Co., 1920. (*c*) Corbitt: How to Improve Your Eyes, Los Angeles, 1930. Ross, J. A., and Rehner, L.: How to Get and Keep Good Eyesight, Garden City, N. Y., Sun Dial Press, Inc., 1943. Huxley, A. L.: Learning to See, Collier's **111**:24 (April 12) 1943. Barensfeld: Aldous Huxley's Seven Years in America, Book Review, New York Times, June 27, 1943.

9. (*a*) Sorsby, A., cited by Huxley,[8a] Appendix I. (*b*) Duke-Elder, W. S.: The Art of Seeing, by A. L. Huxley, Book Review, Brit. M. J. **1**:635 (May 22) 1943; Arch. Ophth. **30**:582 (Oct.) 1943. (*c*) Crisp, W. H.: More About Eye Exercises, Am. J. Ophth. **26**: 872 (Aug.) 1943. (*d*) Pascal, J. I.: On Aldous Huxley's "The Art of Seeing," ibid. **26**:636 (June) 1943. (*e*) Aldous Huxley's Vision, editorial, J. A. M. A. **122**:951 (July 31) 1943.

10. Duke-Elder[9b] referred to them as "Huxley's antics of palming, shifting, flashing, and the rest are probably as good treatment as any other system of Yogi or Coué-ism."

11. It is often pointed out that Huxley's visual acuity has not improved in any extraordinary way. He admits that. The point is that he has learned how to use what he has to better advantage. It is not the primary retinal sensation that is improved; it is the neglected, but vitally important, cerebral part of seeing that has been trained.

and learning lead to better performance, to the acquisition of skill.[12] Many ocular conditions exemplify this law. Since seeing is only partly a matter of the image on the retina and the sensation it produces, but is in still larger part a matter of the cerebral processes of synthesis, in which memories play a principal role, it follows that by repetition, by practice, by exercises one builds up a substratum of memories useful for the interpretation of sensations and facilitates the syntheses which are the major part of seeing. Also, motor functions are perfected by practice, by learning, and reflex pathways are facilitated. Ophthalmologists have neglected this field and have concentrated their attention on the primary source of the sensation, the image on the retina, leaving to irregular, half-trained workers the cultivation of that field. The achievements obtained by the clumsy practices which have been developed should stimulate ophthalmologists to investigate and discover the valuable possibilities in this field which, I am convinced, await intelligent development. Finally, in assessing the value of exercises it must not be forgotten that many patients have a neurotic or psychic element and that such patients are often favorably affected by hocus-pocus. Do not make the mistake of thinking that this is the whole story.

I have said nothing about actual structural changes which are wrought by exercises, other than hyperplasia and hypertrophy of muscles and the consequent changes induced in tendons, and perhaps in bones. Frankly, I am skeptical of such an effect. A clearing of corneal opacities often occurs to a rather slight degree, but not by means of exercises. I doubt whether any changes in size or shape of the eyeball are brought about by such means. Certainly, the burden of proof is on those who make such claims. Permit me to quote Jesus, who said: "Which of you by taking thought can add one cubit unto his stature?"

12. Here are some quotations from Huxley [8a]: "The art of seeing does not stand or fall with any particular hypothesis [page 33]."

"The art of seeing is like other fundamental or primary psycho-physical skills, such as talking, walking and using the hands."

"People may have the most fantastic views about physiology; but this will make no difference so long as their theory and practice of psycho-physical functioning remain adequate to their purpose. If psycho-physical skills depended for their development on a correct knowledge of physiology, then nobody would ever have learnt any art whatsoever. It is probable, for example, that Bach never thought about the physiology of muscular activity; if he did it is quite certain that he thought incorrectly. That, however, did not prevent him from using his muscles to play the organ with incomparable dexterity [page 34]."

PARTIAL RESECTION OF THE LID AND PLASTIC REPAIR FOR EPITHELIOMA AND OTHER LESIONS INVOLVING THE MARGIN OF THE LID

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It is frequently advisable to excise an epithelioma involving the margin of the lid, and technics which I have found satisfactory for doing this will be described here.

The principle, which is based on the use of a sliding graft from the temple, is not new, and even the particular methods given here have been employed in general by others. For the most part, these techncis were used by Wheeler.[1] I describe them here for the purpose of mentioning certain modifications and emphasizing certain steps which I have deemed important in the performance of 34 such operations.

It is not within the scope of this article to discuss the relative merits of irradiation and surgical procedures in the treatment of epithelioma of the lid. Suffice it to say that in my opinion surgical treatment seems to be the therapy of choice in most instances. Operation is usually adequate to control the growth, gives a better cosmetic result and leaves a more comfortable and better functioning eye and lids. It enables the patient to forego the frequently untoward sequelae of irradiation, such as defect in the cilia line and the margin of the lid, atrophy and telangiectasis of the adjacent skin, new-formed and dilated blood vessels of the conjunctiva, keratinization of the palpebral, bulbar and even the corneal epithelium, and cataract. In cases of recurrence of the epithelioma after irradiation, further irradiation is sometimes contraindicated, and surgical intervention is imperative. In other cases, when the lesion is extensive, irradiation should be carried out first and the operation here described done later in order to repair the residual defect in the lid (fig. 16 *A*, *B*, *C*, and *D*). These operations can also be used to excise a nevus and a hemangioma of the margin of the lid and to repair a congenital (fig. 17 *A* and *B*) or a traumatic (fig. 18 *A* and *B*) coloboma of the lid.

A good cosmetic result may be expected. There should be no defect in the continuity of the lid margin or the cilia line at the site of the anastomosis, and there should be a good cul-de-sac. It is fortunate that most epitheliomas of the lid involve the lower lid, for the lower lid is more easily repaired than the upper. The operations can, however, be employed satisfactorily on both lids. The technics as applied to the lower lid will be described, and any modifications necessary for their employment on the upper lid will be mentioned.

When the lesion to be excised requires the resection of approximately one third or less of the length of the lid, a somewhat simpler procedure can be carried out than when a greater resection is necessary. The decision as to whether the operation for the lesser or the greater resection should be employed depends a great deal on the individual case. When the lid is lax, as it is likely to be in some persons, especially in older patients, the simpler procedure can be used to fill a larger defect than would otherwise be possible.

The simpler procedure is as follows: Local infiltrative and block anesthesia are satisfactory. With a Graefe knife the lid is halved on each side of the lesion for 3 to 4 mm. (fig. 1). The distance from the lesion at which the halving is started depends on the distance the lesion infiltrates. The halving should be started beyond the limit to which the lesion is thought to extend.[2]

The external half of the lid should include skin, cilia and orbicularis muscle, while the internal half should include conjunctiva and tarsus. The depth to which the halving extends depends on the width of the piece of lid to be resected, but usually the distance is 6 to 8 mm.

A silk traction suture is passed through the lesion to facilitate manipulation (fig. 1). The lesion is excised by removing the desired amount of lid in the shape of a square or rectangle (fig. 2). This consists of a block resection of the entire thickness of the lid, including the conjunctiva. A square or rectangle is better than

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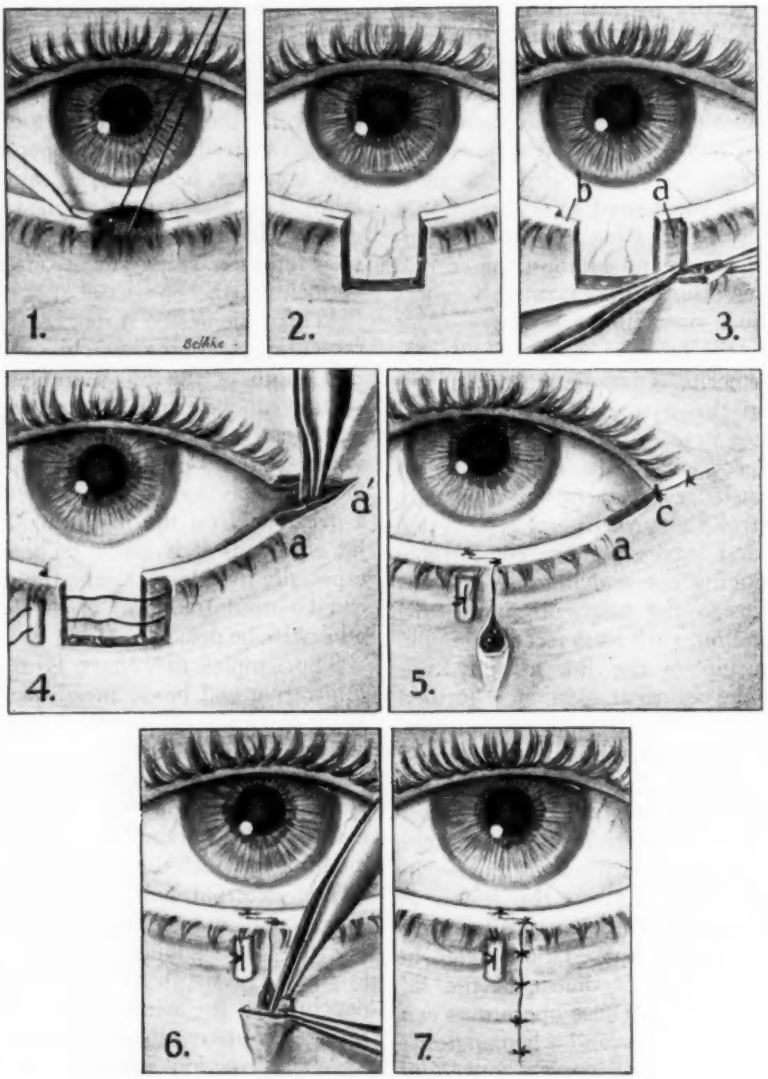
From the Institute of Ophthalmology of the Presbyterian Hospital and the Memorial Hospital for the Treatment of Cancer and Allied Diseases.

1. Wheeler, J. M.: Collected Papers of John M. Wheeler, New York, Columbia University Press, 1939, pp. 338-342.

2. The drawings for both of the operative procedures show the excision close to the lesion, a nevus. The distance from the lesion the excision should be made depends of course on the individual case.

a V because less lid margin has to be sacrificed and the anastomosis can be made more accurate. The anterior half of the lid at one edge is then excised over the region which was halved (fig. 3, *a*), and the posterior half of the other edge is excised over the region which was halved (fig. 3, *b*). An external canthotomy is then done, its direction being slightly upward to follow the contour of the lower lid (fig. 4, *a* to *a'*). Scissors are inserted in the canthotomy opening between the skin and the conjunctiva, and the lower portions of the external canthal ligament are incised until the external portion of the lower lid is sufficiently released to permit it easily to fill the defect left by the resection. A double arm silk suture is then placed through the posterior lip of the halving and carried through the anterior lip (fig. 4). This double arm silk suture should be so placed that there is overcorrection when the halved edges come together. The release of the lateral portion of the lid at the external canthus should be sufficient for the halved edges to approximate easily without requiring tension on the double arm suture. The double arm suture is then tied over a rubber pig (fig. 5). This leaves a puckering of the skin below the lid anastomosis (fig. 5). A triangular piece of this skin is excised (fig. 6), and the edges of the skin are approximated with silk sutures (fig. 7). Several sutures can be used to approximate the halving along the margin of the lid if necessary. An interrupted silk suture is placed at the point designated as *C* in figure 5 to determine the new external canthus, and several other interrupted silk sutures are placed to approximate the edges of

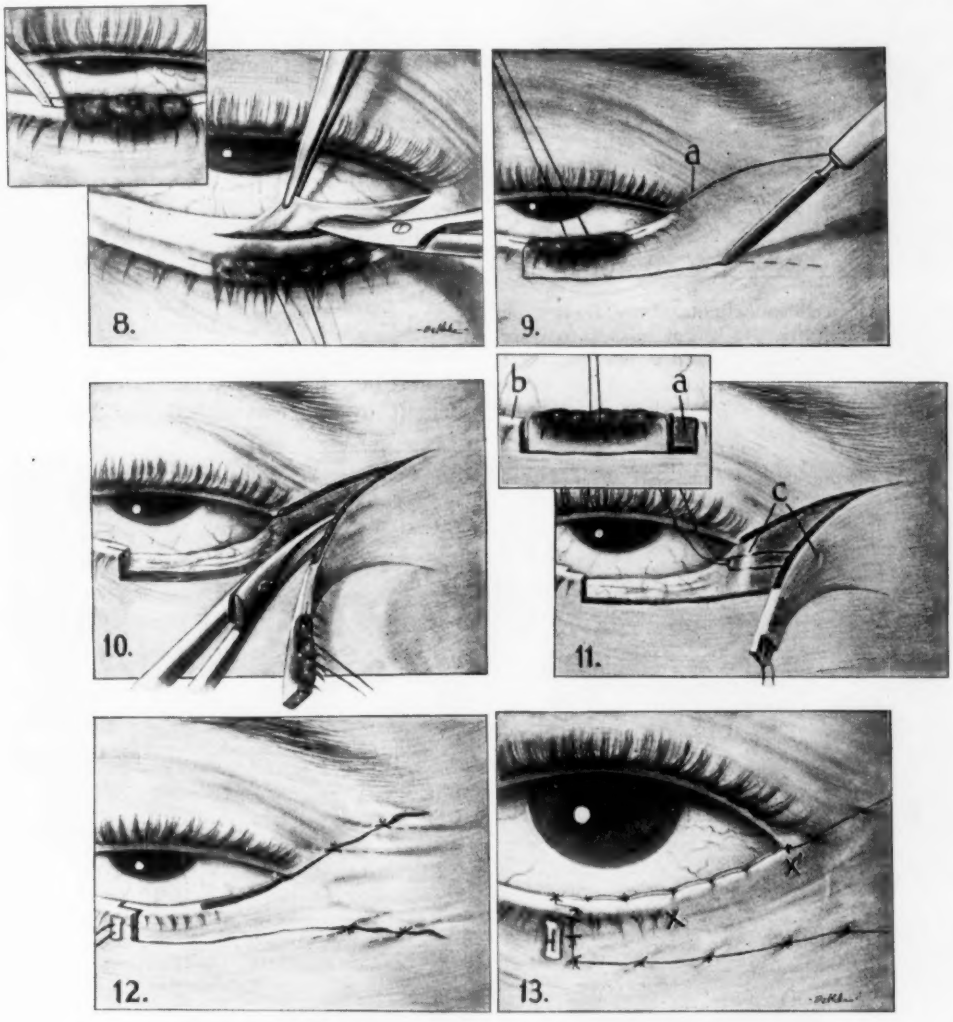


Figs. 1-7.—Excision of nevus by the procedure of halving.

the skin over the site of the external canthotomy. This leaves an area from *a* to *c* (fig. 5) to form the new-formed lid margin, and along this edge no further suturing is necessary. The same technic is applicable to both the upper and the lower lid.

A result using this technic is shown in figure 14 *A* and *B*.

When the lesion to be excised requires the resection of more than one-third the length of the lid, a more extensive operative procedure is (fig. 8). As much as possible of the conjunctiva of the lid is salvaged. With the exception of that portion firmly adherent to the tarsus, all the conjunctiva can usually be saved unless the lesion extends through the entire thickness of the lid to involve the conjunctiva. This dissected and free conjunctiva is now pushed down into the cul-de-sac and forgotten till the end of the operation. With a scalpel, the amount of the lid to be included in the resection and sliding graft is outlined on the skin (fig. 9). This should



Figs. 8-13.—Resection of a portion of the lid, with repair by a sliding temporal graft.

indicated, a description of which follows. Local infiltrative and block anesthesia are satisfactory. The halving is carried out in the same manner as described in the previous procedure (fig. 8, insert).

A silk traction suture is passed through the lesion to facilitate manipulation of the lid (fig. 8). The conjunctiva is dissected from the posterior surface of the lid to the cul-de-sac be so fashioned that the incisions diverge temporally to make the base of the graft progressively broader for nutritional purposes. Rather than to continue the upper temporal cutaneous incision in line with the lower lid, it is better to carry it somewhat higher (fig. 9, *a*). In any case, caution should be taken not to carry it lower. This suggestion is advisable because of a tendency to a slight depression of the lid

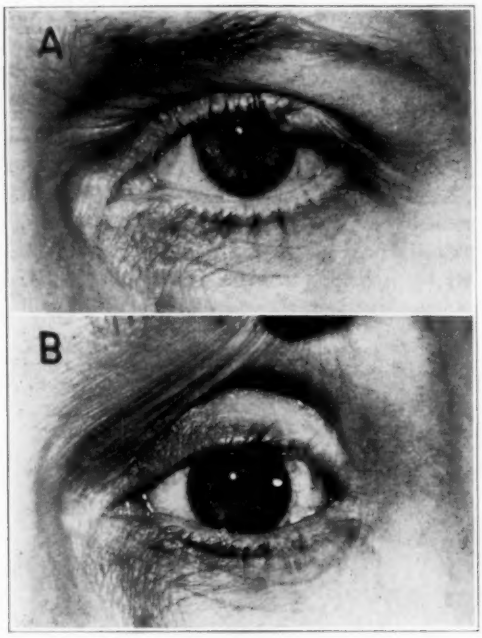


Fig. 14.—*A*, basal cell epithelioma of the right upper lid, proved microscopically. It was necessary to resect approximately one third of the lid. The procedure shown in figures 1 to 7 was carried out. There was sufficient uninvolved lid margin at the temporal side for the anastomosis. The patient was well two years after operation.

B, right eye of the patient one year after operation.

margin at the junction of the old and the new lid margin.

The vertical incision through the lid nasally is now completed, as well as the horizontal incisions, and the portion to be resected, as well as the portion to be included in the sliding graft, is dissected free into the temporal region (fig. 10). The distance into the temporal region to which the dissection is carried depends on the amount of the defect to be filled by the sliding graft. Up to this point, if the lesion is not ulcerated and infected, that portion of the lid which is to be resected has not been removed. It is left intact in the interest of easier manipulation of the lid during the dissection. The part of the lid to be resected is now excised (fig. 11, insert). The remaining margins of the lid are now prepared for the halving procedure, as described in the previous operation. The anterior half (cilia, skin and orbicularis muscle) of the temporal edge is excised over the region which was halved (fig. 11, inset *a*), and the posterior half (tarsus and conjunctiva) of the nasal edge is excised over the region which was halved (fig. 11, inset *b*). The skin and cilia should be left on the nasal side, so that they can benefit by the established blood supply of this

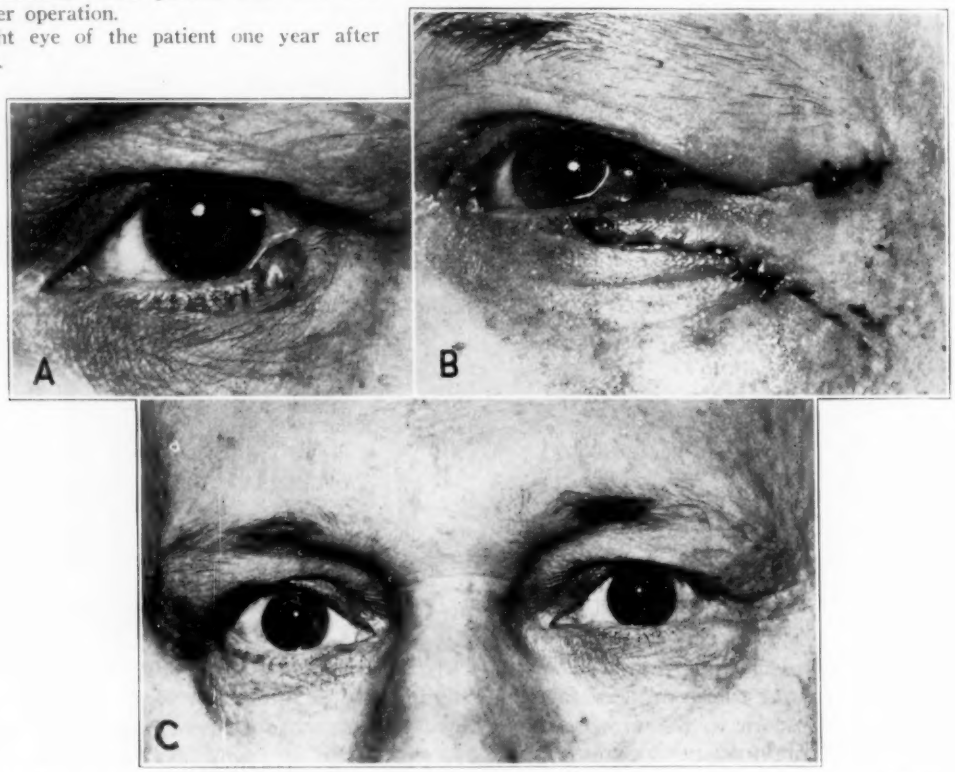


Fig. 15.—*A*, a basal cell epithelioma of the right lower lid, proved microscopically. The lesion had infiltrated to a considerable extent, so that it was necessary to resect approximately one half of the lid. The procedure shown in figures 8 to 13 was carried out. There was sufficient uninvolved lid margin temporally for the anastomosis. The patient was well four years after operation.

B, site of operation on the fifth postoperative day, with sutures in place.

C, appearance one year after operation.

portion of the lid. That portion of the sliding graft which will participate in the new part of the lower lid should be thin, but the graft should then become progressively thicker toward its base. A double arm silk suture is placed through the complementary halves of the lid margin so that there will be some overcorrection of the anastomosis, as described in the previous operation. The temporal flap should have been sufficiently undermined to permit a comfortable sliding of the graft to fill the defect. A subcutaneous double arm surgical gut suture should be placed under the temporal flap and passed through the periosteum at the external orbital margin (fig. 11 *c*) in such a manner that when the suture is tied the temporal flap will be slid nasally to fill the defect. The temporal flap is pulled farther nasally by interrupted silk sutures so placed that when tied they draw the flap toward the defect (fig. 12). This should be accomplished mainly by sutures placed along the lower horizontal incision rather than the upper, because the upper edge of the skin is more lax and if too much pull is attempted here the upper lid will be pulled laterally, with a tendency to lengthen and narrow the palpebral aperture. The double arm silk suture uniting the halved portions of the lid is now tied over a rubber pig (fig. 13). In order to minimize the chances of interference with the nutrition of the tip of the graft, with production of slough, no tension should be put on this suture in uniting these complementary portions of the lid margin, and the suture should not be tied too tight. Interrupted silk sutures unite the margins of the skin. It is important to place accurately an interrupted silk suture to determine properly the new external canthus (fig. 13, x'). The edge of the palpebral conjunctiva is now united to the lid margin with interrupted plain surgical gut sutures (fig. 13). The new lid margin is now between X and X' (fig. 13). In order to accomplish the necessary pull of the graft toward the defect to be filled, the placing of interrupted silk sutures may occasion some puckering of the skin. This can be ignored, as it smooths out and causes no untoward blemish.

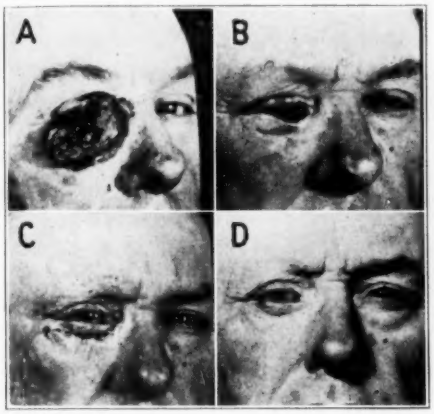


Fig. 16.—*A*, an extensive ulcerated and fungating basal cell epithelioma, involving mostly the lower lid.

B, disappearance of the lesion after roentgen irradiation, leaving a defect in the lower lid.

C, result of plastic repair of the defect by the procedure described in figures 8 to 13, as seen on the ninth postoperative day, with sutures in place.

D, patient one and one-half years after operation. He is still well, five years after operation.

When the defect to be filled in the lid is large, it is not sufficient to make the upper horizontal incision only, for this will produce a tendency in the lid margin to evert. This tendency is overcome by making the lower horizontal incision.

A result using this technic is shown in figure 15, *A*, *B* and *C*.

The same procedure can be applied to the upper lid. On the upper lid, however, it is somewhat more difficult to secure the necessary pull for sliding the temporal graft over to fill the defect in the lid. This is true because the lower edge of the skin is continuous with the mobile lower lid and the upper edge of the skin is lax. On the upper lid it is necessary, therefore, to carry out the dissection farther temporally and

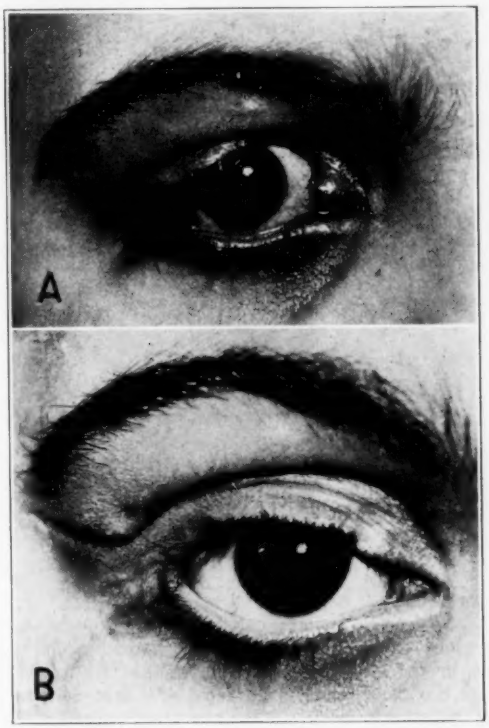


Fig. 17.—*A*, congenital coloboma of the right upper lid. *B*, repair of the lesion by the procedure described in figures 8 to 13.

to rely less on pull from suturing. When the operation is done on the upper lid, there is no material interference with the levator function, provided several plain surgical gut sutures approximate the severed levator muscle to the upper margin of the remaining tarsus and the conjunctiva and edges of the skin are well approximated. Dissection of the conjunctiva from the upper lid must start at the upper margin of the tarsus because over the tarsus the conjunctiva is too adherent. Since this region is inaccessible at the completion of the operation unless undue strain is put on the lid anastomosis, it is necessary to do the conjunctival suturing before this anastomosis is completed. Regardless of how much the lid is to be resected, the width of the resected portion should always be sufficient for the upper horizontal incision to extend along the normal horizontal fold of the upper lid. While the procedure described here can be used to repair any amount of defect in the lower lid (even one involving the entire lower lid), it is not applicable to repair more than one half of the upper lid.

In any halving procedure on the lid, a more satisfactory anastomosis is obtained between actual lid margins than between a lid margin and skin. However, it is necessary to anastomose lid margin to skin when the lesion to be excised is so close to the external or the internal canthus that no lid margin is available on one side. Also, when one side of the anastomosis is beyond the termination of the tarsus, and therefore does not include tarsal tissue, the approximation of the two edges of the lid is not accurate, because the double arm suture yields more on the side without tarsal tissue. In such instances, the sliding graft should be more extensively undermined to permit a more generous slide.

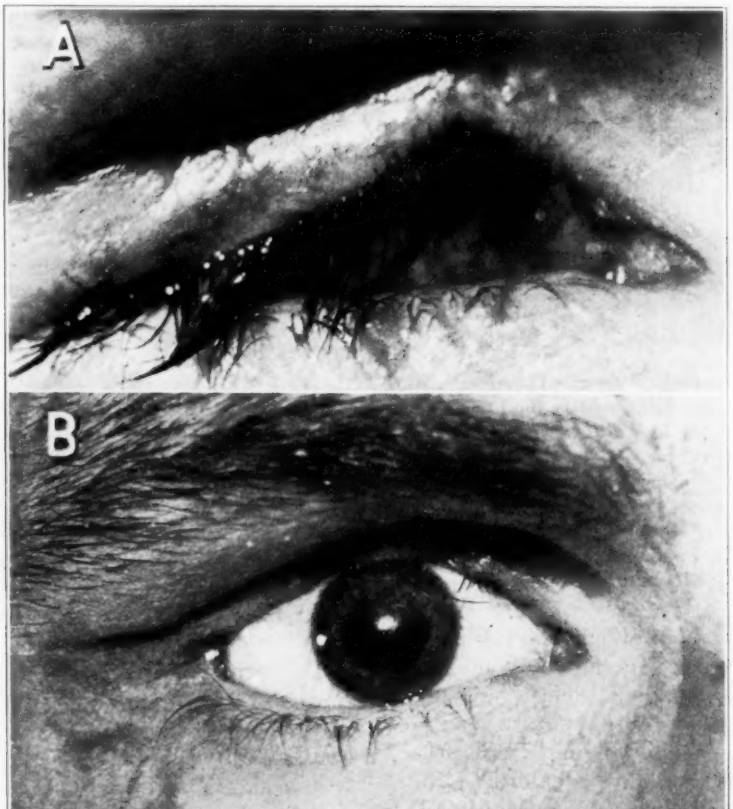


Fig. 18.—*A*, traumatic coloboma of the upper lid sustained in an automobile accident from laceration with glass. The globe was enucleated, and the patient could not wear a prosthesis because of cicatricial contraction of scar tissue in the coloboma. The cul-de-sac was obliterated by the scar over its course posteriorly. A block resection of the coloboma and adjacent scar was done by the procedure described in figures 8 to 13.

B, prosthesis worn six months after operation.

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EXPERIMENTAL STUDY ON PENICILLIN TREATMENT OF ECTOGENOUS INFECTION OF VITREOUS

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NEW YORK

In general, ectogenous infections of the vitreous respond unsatisfactorily to any type of therapy. The stimulation of the humoral and cellular body defenses by fever treatment and shock therapy and by local methods, such as withdrawal of small amounts of vitreous (Elschnig,[1] Löwenstein and Samuels[2] and Zur Nedden[3]) did not as a rule prevent the loss of function in the diseased globes. The topical and systemic chemotherapeutic procedures of former days barely improved the unfavorable prognosis. The present potent and less toxic antibacterial agents, such as the sulfonamide compounds and penicillin, introduced iontophoretically and supplemented by systemic treatment, did not check experimental endophthalmitis when the infection had spread from the anterior segment to the vitreous space.[4] These results were not surprising in view of the slow metabolism of the vitreous and its anatomic position in relation to the main portals of entry of drugs into the eye, that is, to the capillaries of the ciliary body and to the cornea. For example, the concentrations of sulfonamide compounds in the vitreous after systemic use ranged, according to Bellows and Chinn,[5] from 0.9 to 5.8 mg. per hundred cubic centimeters; only traces of sulfadiazine were found in the vitreous after corneal iontophoresis, despite the high concentrations secured in the anterior part of the eye.[6] Attempts failed to increase the concentration of sulfadiazine in the vitreous by transscleral iontophoresis.[7] Penicillin, also, did not enter the vitreous in detectable amounts with either local or systemic administration.[8] Because of the failure of the aforementioned methods to produce adequate concentrations of the chemotherapeutic agents in the vitreous, direct injection of the drug into the vitreous space, hazardous as it seemed, was considered as a possible solution. The low tissue toxicity and the high bacteriostatic action of the newer chemotherapeutic agents reduced some of the objections to the procedure.

The study dealt, first, with the distribution of the drugs in the intraocular fluids at various intervals after their intravitreal injection; second, with the damage to the inner structures of the eye attributable to the mechanical trauma and to the toxic action of the injected compounds, and, third, with the therapeutic effect of the selected drugs on a well standardized destructive infection of the vitreous.

I. DISTRIBUTION OF PENICILLIN AND SULFACETIMIDE IN INTRAOCULAR FLUIDS FOLLOWING INTRAVITREAL INJECTION

Penicillin was selected as the most promising representative of the mold products; sulfacetimide was chosen from the group of sulfonamide compounds because of its almost neutral p_H in solutions of high concentration and because of its effectiveness in various experimental infections of the cornea.[9]

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From the Department of Ophthalmology, Columbia University College of Physicians and Surgeons, and the Institute of Ophthalmology, Presbyterian Hospital.

1. Elschnig, A.: Ueber Glaskörperersatz, Arch. f. Ophth. **80**:514, 1911.

2. Löwenstein, A., and Samuels, B.: Ueber Glaskörperersatz, Arch. f. Ophth. **80**:500, 1911.

3. Zur Nedden, M.: Ueber Glaskörperabsaugungen, Verhandl. d. ausserord. Tag. d. ophth. Gesellsch. (1921), 1922, p. 153.

4. von Sallmann, L.: Penicillin and Sulfadiazine in the Treatment of Experimental Intraocular Infection with Pneumococcus, Arch. Ophth. **30**:426 (Oct.) 1943.

5. Bellows, J., and Chinn, H.: Penetration of Sulfathiazole in the Eye, Arch. Ophth. **25**:294 (Feb.) 1941.

6. von Sallmann, L.: Sulfadiazine Iontophoresis in Pyocyaneus Infection of Rabbit Cornea, Am. J. Ophth. **25**:1292, 1942.

7. Unpublished experiments.

8. von Sallmann, L., and Meyer, K.: Penetration of Penicillin into the Eye, Arch. Ophth. **31**:1 (Jan.) 1944.

9. (*a*) Robson, J. M., and Scott, G. L.: Local Chemotherapy in Experimental Lesions of the Eye Produced by Staph. Aureus, Lancet **1**:100, 1943; (*b*) The Production and Treatment of Experimental Pneumococcal Hypopyon Ulcers in the Rabbit, Brit. J. Exper. Path. **24**:50, 1943. (*c*) von Sallmann.[6]

Technic.—Experiments were carried out on chinchilla rabbits under general anesthesia induced with pentobarbital sodium and local anesthesia induced with 0.1 per cent nupercaine hydrochloride. Two-tenths cubic centimeter of a solution containing 2.5 milligrams of sodium penicillin per cubic centimeter (10 per cent), or a like amount of a 10 per cent solution of sodium sulfacetimide, was injected into the vitreous under sterile conditions after withdrawal of the aqueous. The injection was made with a fine (27 gage) needle, which was thrust into the vitreous in the region of the equator on either side of

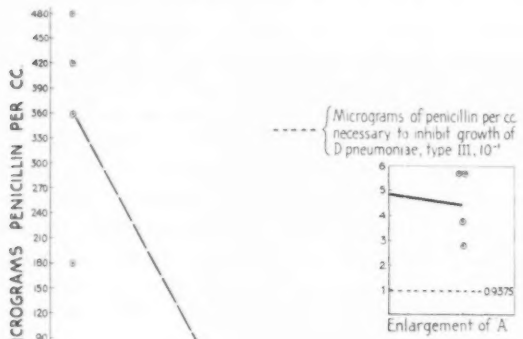
MICROGRAMS PENICILLIN PER CC.
Micrograms of penicillin per cc. necessary to inhibit growth of D. pneumoniae, type III, 10⁻⁴
0.9375
Enlargement of A
A
HOURS AFTER INTRAVITREAL INJECTION

Fig. 1.—Concentration of penicillin in the vitreous of rabbits after a single intravitreal injection of 0.2 cc. of a solution containing 2.5 milligrams of sodium penicillin per cubic centimeter.

the superior rectus muscle. Damage to the lens and to the retina, other than puncture of the latter, was generally avoided by the use of a short, sharp needle. To reduce the trauma of the insertion of the needle into the eye softened by the removal of aqueous, the technic was modified by introducing the needle into the vitreous first, then withdrawing the aqueous and finally injecting the solution of the chemotherapeutic compound. Samples of aqueous and vitreous fluids were taken six, twelve and twenty-four hours after the injection of penicillin for its quantitative determination (four determinations at each interval). The amount of penicillin was calculated on the basis of the highest dilution of aqueous and vitreous which inhibited the growth of test cultures in accordance with a previously reported technic.[4] For the determination of sulfacetimide, the fluids were withdrawn after twelve, thirty-six and seventy-two hours. Sulfacetimide was estimated according to the colorimetric method of Bratton and Marshall.[10]

A simple test demonstrated the location and gross distribution of the penicillin in the vitreous six hours after the intravitreal injection. The eyes were enucleated and frozen with a solid carbon dioxide mixture. They were then dissected in the vertical meridian, and the characteristic yellow pigment accompanying penicillin was visible and easily identified with ultraviolet light.

Results.—Figure 1 shows that after six hours the average level of penicillin in the vitreous was 360 micrograms per cubic centimeter. The individual figures varied from 180 to 480 micrograms per cubic centimeter. Examination of the frozen eyes at this interval showed an uneven distribution of the yellow pigment and its limitation to about one third of the vitreous space. This observation accounts for the variations in the individual experiments. The average concentration of penicillin after twelve hours was 58 micrograms per cubic centimeter, with the individual figures in comparative agreement (45 to 67.5 micrograms per cubic centimeter). After twenty-four hours the average concentration was 4.5 micrograms per cubic centimeter, with the individual values, again, within close range of each other. This amount was almost five times as great as that necessary to inhibit the growth of the test culture. The aqueous did not exert any antibacterial activity six, twelve and twenty-four hours after the intravitreal injection of the penicillin except in one sample, taken after six hours, in which partial inhibition of the growth of the test culture was observed in the first dilution.

The first determination of sulfacetimide was made after twelve hours. Estimations at an earlier period were omitted because of the unequal distribution of penicillin observed on gross examination of the frozen globes six hours after injection. Other determinations were carried out after thirty-six and seventy-two hours (fig. 2). The average of four determinations

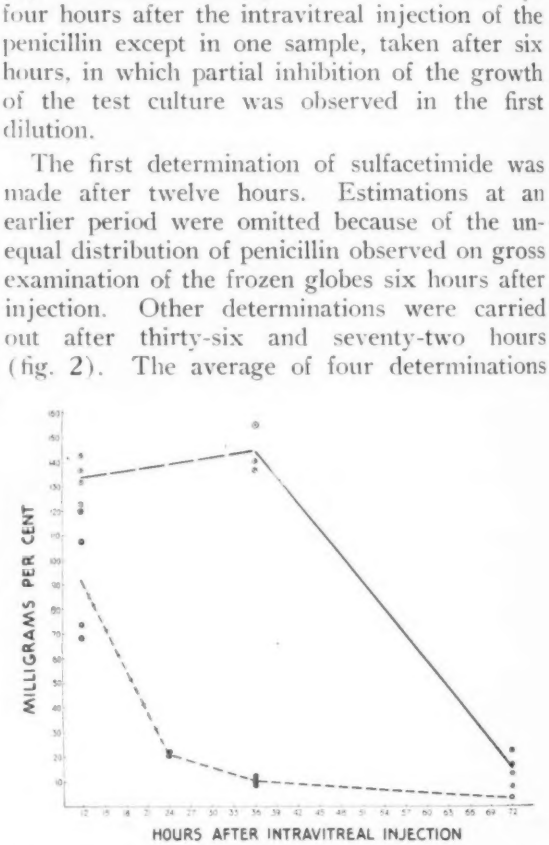

Fig. 2.—Concentration of sulfacetimide in the aqueous and vitreous of rabbits after a single intravitreal injection of 0.2 cc. of a 10 per cent solution of sodium sulfacetimide. Values for the vitreous are shown by a solid line, and those for the aqueous, by a broken line.

after twelve hours was 133.4 mg. per hundred cubic centimeters, 10.9 mg. per hundred cubic centimeters less than the average value after thirty-six hours. The apparent increase in the concentration of sulfacetimide after thirty-six hours is, again, best explained by its incomplete

10. Bratton, A. C., and Marshall, E. K., Jr.: A Coupling Component for Sulfanilamide Determination, J. Biol. Chem. **128**:537, 1939.

diffusion into all parts of the vitreous. After seventy-two hours the average concentration was 15.3 mg. per hundred cubic centimeters. The amount of the sulfonamide compound in the aqueous decreased constantly from 92.2 mg. per hundred cubic centimeters, after twelve hours, to 3.3 mg. per hundred cubic centimeters, after seventy-two hours.

Comment.—Comparatively little is known in regard to the length of time a drug remains in the eye after its introduction into the vitreous. Traces of fluorescein were still visible one week after a 20 per cent solution was injected into the vitreous.[11] It can be assumed that the molecular size of the injected compound[12] and the irritation produced by it are the main factors which govern the rapidity of absorption of the compounds. Also of importance are the binding of the drug to proteins, its osmotic concentration and its distribution between the aqueous phase and cells. Sulfonamide compounds are bound to plasma proteins in varying proportions, and the relative concentration of the drug in the ocular fluids depends on the amount of protein present. Since sulfacetimide usually caused great irritation, its high concentration for three days following its injection may be related to the accompanying increase in the protein to which it was bound. Penicillin was present in the vitreous in amounts considerably higher than the bacteriostatic level for more than twenty-four hours, and sulfacetimide, for more than seventy-two hours. The delayed resorption of penicillin from the vitreous space compares well with the results for the spinal fluid and for the exudate of the pleura and joints after injection into the respective closed cavities.[13] This observation is of foremost interest in the evaluation of intravitreal injection as a therapeutic procedure.

II. IRRITATION AND DAMAGE AFTER INTRAVITREAL INJECTION OF ISOTONIC SOLUTION OF SODIUM CHLORIDE, PENICILLIN AND SULFACETIMIDE

Experiments were conducted to study the effects of one and two injections of penicillin within twenty-four hours. Relatively crude preparations of penicillin of medium potency and of a purity similar to that of commercial clinical preparations were compared in their effect with purified fractions of high potency. Experiments were made to observe the effect of a single injection of sulfacetimide.[8] Control experiments consisted of the intravitreal injection of isotonic solution of sodium chloride. The irritation or damage was studied clinically with the slit · lamp and the ophthalmoscope, histologically by various staining methods and chemically by determinations of the protein content of the aqueous.

Technic.—The technic of injection was the same as that described in the experiments on distribution. Examinations with the slit lamp, carried out at regular intervals, included the inspection of the lens and the anterior part of the vitreous. The deeper parts of the vitreous and the fundus were examined repeatedly with the ophthalmoscope after dilation of the pupil. Histologic examinations were made of pyroxylin sections of the globes in which penicillin had been injected. Most of these eyeballs were fixed in Zenker's solution and the sections stained with hematoxylin and eosin and by the Van Gieson technic and the Weigert method for myelin sheaths. In 8 instances calottes were cut while the eyeballs were frozen, and one part was fixed in alcohol for staining of the Nissl bodies. The protein content of the aqueous was estimated as an indication of the pharmacotoxic action of the compounds on the intraocular capillaries. The determinations were made by a modification of the Looney-Walsh nephelometric method[14] or by the micro-Kjeldahl technic three days after the intravitreal injection of 0.2 cc. of solutions containing 0.9 per cent sodium chloride, 10 per cent sodium sulfacetimide and 0.25 per cent sodium penicillin respectively. The results were correlated with the observations made with the slit lamp and the ophthalmoscope.

Results.—Injection of 0.9 per Cent Sodium Chloride: The irritation observed with the slit lamp and the ophthalmoscope was moderate at all intervals after the injection. Remnants of fibrinous exudate, caused by the mechanical trauma, were occasionally seen in the first few days. A slight flare was sometimes noticed, but almost no cells were present. The vitreous appeared clear except for crystal-like particles behind the lens, which did not interfere with the transparency. No changes in the fundus were noted. After two weeks all signs of irritation disappeared except for a small number of glistening, brown particles in the vitreous. The protein content of the normal aqueous of rabbits ranges from 19 to 51 mg. per hundred cubic centimeters.[15] The average protein concentration of

11. Schöler, H., and Uhthoff, W.: Das Fluorescein in seiner Bedeutung für den Flüssigkeits-Wechsel des Auges, in Schöler, H.: Jahresberichte über die Wirksamkeit der (früher Ewers'schen) Augen-Klinik, Berlin, H. Peters, 1881; abstracted, Jahresb. ü. d. Leistung. d. Ophth. **13**:91, 1882.

12. Penicillin has a molecular weight of about 300, and sodium sulfacetimide, a molecular weight of 222.

13. Rammelkamp, C., and Keefer, C.: The Absorption, Excretion and Distribution of Penicillin, J. Clin. Investigation **22**:425, 1943.

14. Looney, J. M., and Walsh, A. I.: The Determination of Spinal Fluid Protein with the Photoelectric Colorimeter, J. Biol. Chem. **127**:117, 1939.

15. Ayo, C., and Meyer, K.: Protein Content of Rabbits' Aqueous Humor Following Intravenous Injection of E. Coli Toxin, Proc. Soc. Exper. Biol. & Med. **51**:130, 1942.

the aqueous three days after the intravitreal injection of isotonic solution of sodium chloride was 183.2 mg. per hundred cubic centimeters. The difference is indicative of the increase in protein which may be ascribed to the posttraumatic irritation (table 1).

TABLE 1.—*Protein Content of the Aqueous of Rabbits, Expressed in Milligrams per Hundred Cubic Centimeters, Seventy-Two Hours (Four Determinations) After the Intravitreal Injection of 0.2 cc. of:*

Sodium Chloride, 0.9 %	Sodium Penicillin, 2.5 %	Sodium Sulfacetimide 10 %
115	149	265
117	225	688
234	287	1,540
279	327	3,640
Average 183.2	247	1,533

Injection of Solution of Sodium Penicillin in Concentration of 2.5 Milligrams per Cubic Centimeter: After one injection of a purified fraction of penicillin (11 eyes), the signs of irritation as observed with the slit lamp and the ophthalmoscope differed from those with the isotonic solution of sodium chloride in a moderate increase of the flare and in the presence of a few cells circulating in the aqueous. A slight opacity, in the form of a veil or a small cloud, was present in the vitreous, in addition to crystalline deposits in the anterior layers which resembled those after injection of the sodium chloride solution. The opacity was usually resorbed within a short period, and the number of crystalline deposits was greatly reduced in two months. As a rule, the ophthalmoscopic examination revealed a normal fundus, especially a normal appearance of the fine striations of the medullated nerve fibers.

From 149 to 327 mg. per hundred cubic centimeters of protein was present in the aqueous of 4 eyes three days after the injection of purified penicillin (table 1). Histologic examination of 2 eyes removed five days after the injection revealed a moderate number of cells, mostly round cells, in the anterior and posterior border layers of the vitreous. The vitreous was not detached, but the extent of its destruction could not be established because of the fixation. The nature of the crystalline deposits behind the lens, which were visible with the slit lamp, could not be identified with the microscope, although amorphous granular debris in this area probably represents their histologic substrate. The lens and uvea appeared normal except in 2 eyes, which displayed loss of the fibrillar structure in a localized part of the subcapsular cortical layers near the posterior pole of the lens (table 2). Examination at later periods (2 eyes after two weeks; 4 eyes after four weeks) revealed a similar mild inflammatory reaction. In 7 instances the retina was free of pathologic changes. No evidences of degeneration of the Nissl bodies or of the nuclei of the ganglion cells were revealed by the Nissl stain. Gross changes of the medullated nerve fibers were not demonstrated by the Weigert stain for myelin, but finer lesions cannot be recognized with this method. The visual cells and pigment epithelium appeared normal. On the other hand, in 4 eyes circumscribed areas of 1 or 2 disk diameters presented different degrees of atrophy of the retina, beginning with granular disintegration of the outer segment of the rods and advancing to changes in chromatin of the outer nuclear layer and, finally, to rarefication of all cellular elements and their replacement by glial elements. The pigment epithelium was involved secondarily.

TABLE 2.—*Damage to Lens, Vitreous and Retina After Injections of Penicillin into the Vitreous of Normal Eyes*

Type of Penicillin Preparation	Number of Injections of Penicillin	Number of Eyes	Lens		Vitreous		Retina		
			Clear	Localized Posterior Cortical Cataract	Clear *	Extensive Exudate	Normal	Localized Atrophy	Extensive Destruction
Highly purified	1	11	9	2	11	..	7	4	..
	2	3	1	2	2	1	..	1	2
Less purified	1	2	..	2	2	..	..	2	..
	2	5	1	4	1	4	..	2	3

* No or few inflammatory cells.

A single injection of a crude preparation of penicillin (2 eyes) caused slightly greater irritation than that of a purified fraction of penicillin. This was evidenced by an increased flare and a greater number of cells in the anterior chamber and by the larger amount of opacities in the vitreous. These changes regressed and disappeared within two to four weeks. Crystalline deposits, similar to those observed after the injection of a purified preparation, were present behind the lens. In the examination with the ophthalmoscope the medullated nerve fibers appeared to have lost parts of the finer striations in some instances, and the area of the medullated

nerve fibers was reduced. Histologic examination of the eyes enucleated four weeks after the injection confirmed the presence of a more extensive damage to the retina. In 1 instance a flat, localized detachment of the retina was seen, with a small amount of subretinal fluid, which was rich in protein. The outer segments of the rods were broken into a mass of pale-staining granules intermingled with large droplets, which may have been secreted by the pigment epithelium.[16] In a number of places the cells of the pigment epithelium showed exfoliation, proliferation and the common variety of degenerative changes with which the epithelium responds to damage of the rods and cones. In addition to the histologic changes in the retina, the lens presented lesions in the posterior subcapsular layer, which were not clearly seen with the slit lamp. The fibers were swollen and club shaped near the posterior pole, and few epithelial cells were visible in this area. The vortex of the lens did not show pathologic changes.

The damage was greatly increased when a second injection of either preparation was made after twenty-four hours (8 eyes). The Tyndall sign became much more intensive and the cells more numerous. The extensive exudate in the vitreous caused a diffuse opacity, which made examination of the fundus impossible. After four weeks the condition improved, but opacities in the vitreous were still present in considerable numbers. A severe intravitrael hemorrhage occurred in a rabbit which moved unexpectedly during the procedure of injection. With the slit lamp a diagnosis was made in most instances of a slight opacity in the posterior cortex of the lens. In a few instances examination of the fundus became possible after partial resorption of the exudate and revealed small hemorrhages near the optic nerve, a flat retinal detachment and reduction of the medullated nerve fiber area, suggestive of partial atrophy. The irritation of the eye in this series of experiments was so obvious that determinations of protein in the aqueous did not seem necessary. The histologic examination confirmed and amplified the clinical findings. The cataractous changes, although limited to the superficial cortical layers at the posterior pole, were more advanced than those after a single injection. In the vitreous, remnants of exudate showing signs of organization were occasionally anchored on or around the disk. The traction they exerted may have been the cause of retinal detachment in 3 eyes, but more frequently a flat retinal detachment of the exudative type occurred, with partial decomposition of the outer segments of the rods and cones. The circumscribed area of retinal atrophy described as an occasional lesion in the eyes which received one injection was constant and more extensive in the eyes which received two injections. The intraocular hemorrhage in the cited case extended to the retroretinal space and caused extensive total detachment with vast destruction of the retina.

Injection of 10 per Cent Sodium Sulfacetimide: A single injection of a 10 per cent solution of sodium sulfacetimide was followed in the first three days by an inflammatory reaction, which usually exceeded that after a single injection of penicillin. The flare in the anterior chamber was more pronounced and lasted several weeks. The cells were numerous and formed a carpet-like layer on the anterior surface of the lens within the pupil. Crystalline deposits were present in the anterior layers of the vitreous, and a moderate number of opacities in the vitreous were seen for a few days. In 1 out of 10 eyes the fundus displayed a grayish area of about 2 disk diameters, which probably represented edema. No other changes of the fundus were noticed. Four determinations of the protein content of the aqueous three days after the intravitreal injection showed an average concentration of 1,533 mg. per hundred cubic centimeters, with a range of from 265 to 3,640 mg. per hundred cubic centimeters (table 1). Histologic examinations were not made.

Comment.—The injection of the newer chemotherapeutic agents into the vitreous was based on their high potency and low tissue toxicity, the latter factor distinguishing them from most other antibacterial drugs which are protoplasmic poisons. Comprehensive studies on cells and tissue cultures, that is, leukocytes, fibroblasts, epithelial tissue and microphages, were reported by Abraham and his co-workers.[17] Penicillin was found to be less toxic than sulfonamide compounds to leukocytes in vitro, and both were considerably less toxic than the flavines. Experiments on various laboratory animals (mice, guinea pigs and rabbits) showed the low acute toxicity of penicillin,[18] the toxicity being highest with fractions containing the more pigmented and less acidic components.

The studies on intravitreal injection were further encouraged by the tolerance of the vulnerable nervous system to high levels of peni-

16. Koyanagi, Y., and Kinnikawa, C.: Gleichwertige Veränderungen des retinalen Pigmentepithels und des renalen Tubulusepithels bei verschiedenen Vergiftungen, Arch. f. Ophth. **137**:261, 1937.

17. Abraham, E. P.; Chain, E.; Fletcher, C. M.; Gardner, A. D.; Heatley, N. G.; Jennings, M. A., and Florey, H. W.: Further Observations on Penicillin, Lancet **2**:177, 1941.

18. (*a*) Fleming, A.: The Antibacterial Action of Cultures of a Penicillium, with Special Reference to

cillin and by the introduction and maintenance of high concentrations in closed body cavities without untoward effects.[15] The toxic action of injections of penicillin on subcutaneous tissue and adjacent voluntary muscles was studied by Hamre and her associates,[18f] who described edema and infiltration with monocytes and polymorphonuclear leukocytes in the subcutaneous tissue and destruction, infiltration and phagocytosis of the muscle fibers. Selbie and McIntosh[18g] showed that intramuscular injections of penicillin in mice caused a relatively slight degree of muscle necrosis as compared with other chemotherapeutic drugs. Although these experiments were not closely related to the studies on the eye, they pointed to the necessity for careful investigation of the effect of intravitreal injections on the delicate ocular structures.

Only 1 case has been reported in which one of the newer antibacterial drugs was introduced directly into the eye; Igersheimer[19] injected sulfanilamide into the anterior chamber of an eye with post-traumatic iridocyclitis, with an extremely good result. The effect on rabbits of intravitreal injections of a solution of sodium chloride to replace aspirated vitreous was studied by Löwenstein and Samuels.[2] Elschnig[1] and later Zur Nedden,[3] applied this treatment with some modifications to human eyes with hemorrhages and infections of the vitreous. The trauma of the injection was well tolerated despite the large size of the needle necessary for this procedure. In the experiments reported here the use of a large needle was avoided in reducing the content of the eye by withdrawal of aqueous instead of vitreous fluid. The use of a 0.25 per cent solution of sodium penicillin was based on previous experiments on the anterior segment of the eye[4]; a 10 per cent solution of sodium sulfacetimide was selected in view of the studies of Robson and Scott[20] on experimental infections of the cornea. Further experiments will demonstrate the extent to which the dose may be reduced to keep damage at a minimum without an essential curtailment of the therapeutic effect. As the experiments so far reported were made on the eyes of rabbits and present only the initial approach to a study of intensive local treatment of acute infections of the vitreous, modifications in technic may be necessary for application to the human eye.

The structures of the eye which showed signs of damage attributable to the intravitreal injection were the vitreous, the lens and the retina. The slight opacities in the vitreous visible after a single injection of the purified preparation of penicillin were resorbed within a few days to two weeks. They were somewhat more extensive and numerous when the cruder preparation was used. A second injection, given twenty-four hours after the first, caused heavy exudation into the vitreous; this exudate occasionally became organized and led to retinal detachment. The crystalline deposits seen in the anterior layers of the vitreous after injection of penicillin and sulfacetimide, as well as in the control eyes, were similar to the glistening deposits described by Löwenstein and Samuels,[2] who concluded that they were particles of destroyed vitreous framework. These changes may be disregarded as they did not interfere with the transparency of the vitreous and showed a tendency to resorb.

A single injection of the purified preparation of penicillin did not cause any detectable damage to the lens; the rupture of the lens capsule at the posterior pole on fixation with Zenker's solution and on dehydration interfered, however, with a systematic histologic study.[21] Microscopic lesions were seen in the subcapsular layer of the posterior cortex in several eyes which had been given one injection of a crude preparation. Almost all eyes with two injections of either preparation displayed early stages of a posterior cortical cataract on examination with the slit lamp. The extent of the lesion may have depended on the nearness of the injected material to the posterior pole of the lens. In a small percentage of all experiments the lens was injured by the needle. It can be stressed, however, that the relative size of the lens and vitreous space in the human eye reduces the possibility of damage to the lens—either chemical or traumatic.

Their Use in the Isolation of B. Influenzae, Brit. J. Exper. Path. **10**:226, 1929. (*b*) Chain, E.; Florey, H. W.; Gardner, A. D.; Heatley, N. G.; Jennings, M. A.; Orr-Ewing, J., and Sanders, A. G.: Penicillin as a Chemotherapeutic Agent, Lancet **2**:226, 1940. (*c*) McKee, C., and Rake, G.: Biological Experiments with Penicillin, J. Bact. **43**:645, 1942. (*d*) Florey, H. W., and Jennings, M. A.: Some Biological Properties of Highly Purified Penicillin, Brit. J. Exper. Path. **23**:120, 1942. (*e*) Robinson, H. J.: Toxicity and Efficacy of Penicillin, J. Pharmacol. & Exper. Therap. **77**:70, 1943. (*f*) Hamre, D.; Rake, G.; McKee, C., and MacPhillamy, H.: The Toxicity of Penicillin as Prepared for Clinical Use, Am. J. M. Sc. **206**:642, 1943. (*g*) Selbie, F. R., and McIntosh, J.: The Action of Chemotherapeutic Drugs (Including Proflavine) and Excipients on Healthy Tissue, J. Path. & Bact. **55**:477, 1943. (*h*) Abraham and others.[17]

19. Igersheimer, J.: Intraocular Injection of Sulfanilamide in a Case of Purulent Iridocyclitis, Am. J. Ophth. **26**:1045, 1943.

20. Robson and Scott (footnotes 9 *a* and *b*).

21. von Hippel, E.: Ueber verschiedene Formen von angeborener Cataract und ihre Beziehung zueinander, Arch. f. Ophth. **54**:48, 1902.

Great care was exercised in the study of possible damage to the retina in view of the sensitivity of its cellular elements. In general, the different methods of examination revealed no toxic action due to a single injection of the purified fraction of penicillin except for circumscribed lesions in a few eyes, apparently caused by the unequally distributed drug. The solution may have remained in contact with the retina in relatively high concentration for several hours because of the slow diffusion within the vitreous gel and may have caused the damage characterized by degeneration of the visual cells. Here, again, the anatomy of the human eye will probably safeguard the retina, since the point of the needle can be placed at some distance from it. The volume of the vitreous of the human eye measures about 4 cc. and is about three-fifths the total volume of the globe, whereas in rabbits the volume of the vitreous is 1 to 1.5 cc. and is approximately three-tenths the total volume of the globe.

Injection of a crude preparation, especially the repetition of the injection after twenty-four hours, increased the inflammatory reaction. Greater irritation was expected from the use of a relatively crude fraction in view of the increase in general toxicity with unpurified penicillin.[22] Much more extensive damage to the retina was produced by two injections than by one injection of either preparation. The danger of causing a retinal detachment by mechanical trauma may be ignored in view of the experiments reported here and those of Löwenstein and Samuels [2] and in view of the clinical observations of Elschnig,[1] Zur Nedden [3] and others. The use of a fine needle makes the procedure less objectionable and less likely to cause an intravitreal hemorrhage than the clinically accredited method for withdrawal and replacement of the vitreous. In conclusion, in consideration of the unfavorable prognosis in cases of exogenous infection of the vitreous, a single injection with a solution of purified penicillin may be regarded as a reasonably safe therapeutic procedure, especially when the injection is placed in the central portion of the vitreous.

III. EFFECT OF INTRAVITREAL INJECTION OF PENICILLIN AND SULFACETIMIDE ON EXPERIMENTAL STAPHYLOCOCCIC INFECTION OF THE VITREOUS

Pneumococcic infections are more frequent than staphylococcic infections in cases of perforating injury of the human eye. In rabbits, however, the former often caused a septicemia which originated from the untreated control eye. Therefore, a staphylococcic infection of the vitreous was selected as the test object for treatment. A hemolytic, mannitol-positive strain of Staphylococcus aureus, isolated from a culture of material taken from a destructive corneal ulcer of the human eye, was used in all experiments. The strain displayed in sensitivity tests an average susceptibility to penicillin; that is, growth of a 10^{-2} dilution of a broth culture was inhibited by 0.277 microgram of the purified penicillin fraction used. Diplococcus pneumoniae, type III, was inhibited by 0.078 microgram of the same preparation of penicillin.

Technic.—Five-hundredths cubic centimeter of a twenty-four hour broth culture of Staph. aureus in a dilution of 10^{-4} or 10^{-5} was injected into the vitreous, with the use of local anesthesia, without prior withdrawal of aqueous. In the first four experiments with penicillin dilution of the broth culture was 10^{-4}; in all other experiments a dilution of 10^{-5} was injected. In the first series of experiments treatment consisted of one or two injections of 0.2 cc. of a solution containing 2.5 mg. of sodium penicillin per cubic centimeter (2,500 Oxford units per cubic centimeter). The first injection was made at intervals of six, twelve or twenty-four hours after inoculation. In the initial experiments treatment consisted of two injections and was in several instances supplemented by corneal iontophoresis on the third day. Later, one injection was employed. In the second series of experiments 0.2 cc. of a 10 per cent solution of sodium sulfacetimide was introduced six hours after inoculation with the same technic as that used in the penicillin experiments. All control eyes received 0.2 cc. of a 0.9 per cent solution of sodium chloride.

The course of the inflammation and the effect of the therapy were studied regularly with the slit lamp and the ophthalmoscope. Only a limited number of kodachromes were taken because the photographed changes in the anterior segment did not reflect the severity of the inflammatory process within the vitreous space. The eyes were generally removed after four to five weeks, at a time at which almost all the signs of endophthalmitis had subsided in the successfully treated eyes. A few eyes were enucleated at an earlier stage because of intercurrent disease or accident. Cultures were made of the heart blood when the general condition suggested septicemia. Histologic examinations were made of all treated eyes, as well as of the untreated controls. The same stains as those mentioned in part II were used.

Results.—The infection induced with the technic described led in all instances to the development of an abscess in the vitreous and to phthisis bulbi. In some instances the course was acute, involved the anterior segment and developed into the picture of panophthalmitis with perforation, followed by extreme shrinkage of the eye. In other instances the process was limited to the structures behind the iris diaphragm, with subsequent shrinkage of the globe. The infection

22. Florey and Jennings.[18d] Robinson.[18e] Hamre and others.[18f]

did not cause bacteremia; all cultures of the heart blood were sterile.

The effect of the penicillin therapy depended on the length of time which elapsed between the inoculation and the first treatment. In the first series of experiments broth dilutions of 10^{-4} and 10^{-5} were injected, and six hours later one or two intravitreal injections of penicillin were given. As table 3 shows, the infections were checked in all 10 eyes regardless of the size of the inoculum or the number of injections of penicillin. The same excellent results were obtained in the second series of experiments, in which treatment was initiated twelve hours after the injection of a 10^{-5} dilution of Staph. aureus (fig. 3). It should be emphasized that of the 10 effectively treated eyes of this series, 6 were given only one injection of penicillin. The treatment was unable to check the infection in any of 11 eyes treated twenty-four hours after the inoculation, although a beneficial result was observed in some rabbits. The injection was not repeated because the inflammatory process was so advanced after forty-eight hours that no favorable result could be expected from further treatment.

Injections of sulfacetimide were made in 8 eyes six hours after inoculation. The course of the inflammation did not differ from that in the untreated control eyes except in 1 eye, in which the full development of an abscess of the vitreous was delayed for about a week. A second injection was not administered after twenty-four hours, however, because the suppurative process was obviously beyond control, in spite of the high concentration of the sulfonamide compound which persisted in the inner fluids of the eye for more than three days (part II). The complete failure of sulfacetimide therapy begun six hours after inoculation made experiments with a longer interval unnecessary.

Although the infections were checked in all 20 eyes treated with penicillin six and twelve hours after inoculation, various structures of the posterior segment showed certain signs of damage attributable in part to the infection and in part to the treatment. Some changes were observed by biomicroscopic and ophthalmoscopic studies; others were discovered during histologic examination. Table 4 contains a summary of the changes observed by the various methods

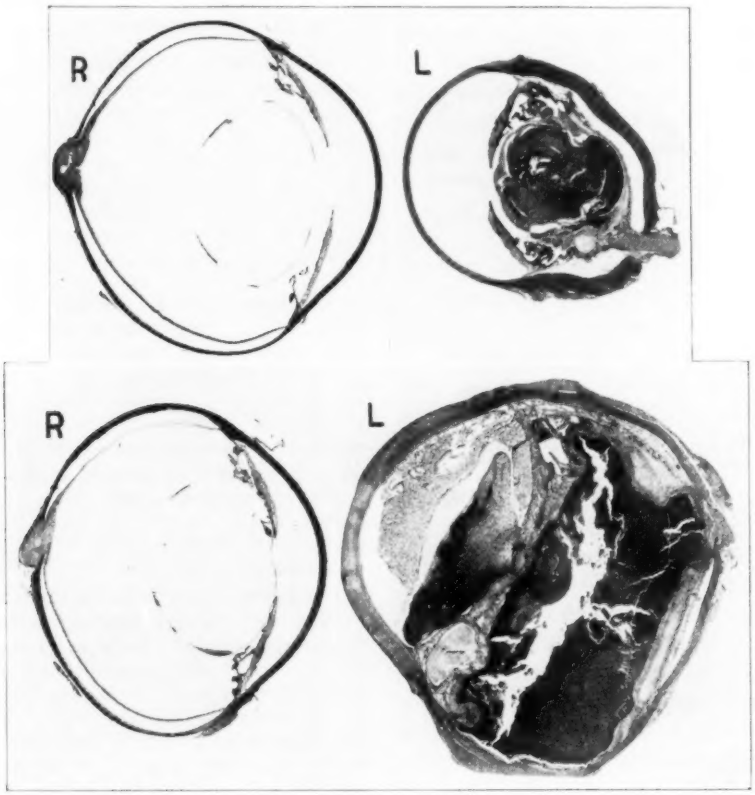

Fig. 3.—Sections of the treated (*R*) and untreated (*L*) eyes of 2 rabbits with staphylococcic infection of the vitreous three weeks after therapy. Treatment consisted of a single injection of 0.2 cc. of a solution containing 2.5 milligrams of penicillin sodium per cubic centimeter twelve hours after inoculation with the organisms.

of examination. Cataractous changes, suggested by slit lamp inspection and identified on histologic examination, were found in 3 eyes in the six hour series and in 6 eyes in the twelve hour experiments. Six of the eyes with a beginning complicated cataract had received two injections of penicillin. Lesions in the lens were composed of subcapsular vacuoles, irregular proliferation of pseudoepithelium on the posterior capsule of the lens and the formation of Wedl's cells. The fibrils at the posterior pole were thickened and swollen, and a fine granular debris and Morgagni spheres were seen in the most advanced cataracts. As a rule the lesions were minor and did not interfere with the visibility of the details of the fundus.

show signs of regression during the period of observation. These strands were identified under the microscope as organized remnants of cellular exudate adherent to the surface of the optic disk or the surrounding retina. The histologic examination in the earlier stages revealed an accumulation of round cells behind the lens and in other parts of the cortex of the vitreous; the exudate was necrotic in sections taken at later stages. The number of injections of penicillin was a definite factor in relation to the extent of the opacity; that is, the second injection increased greatly the inflammatory signs. The time interval between the inoculation and the treatment was of less importance.

TABLE 3.—*Results of Intravitreal Injection of Sodium Penicillin and Sodium Sulfacetimide at Various Intervals After Infection of the Vitreous with Staphylococcus Aureus*

Treatment				Number of Eyes in Which	
Drug	Number of Injections	Hours Between Infection and First Treatment	Total Number of Eyes	Infection Was Checked	Infection Was Not Checked
0.25 per cent sodium penicillin	1	6	4	4	0
	2	6	6	6	0
	1	12	6	6	0
	2	12	4	4	0
	1	24	10	0	10
10% sodium sulfacetimide	1	6	8	0	8
Control eyes—0.9% sodium chloride	1-2	6, 12, 24	20	0	20

TABLE 4.—*Damage of Lens, Vitreous and Retina in the Successfully Treated Eyes with Staphylococcic Infection of the Vitreous Observed Three to Five Weeks After Inoculation*

Number of Injections of Penicillin	Hours Between Infection and First Treatment	Number of Eyes	Lens		Vitreous		Retina		
			Clear	Localized Posterior Cortical Cataract	Clear *	Extensive Exudate	Normal	Localized Atrophy	Extensive Destruction
One	6	4	3	1	4	..	1	2	1
	12	6	4	2	4	1	5	1	..
Two	6	6	4	2	5	1	4	1	1
	12	4	..	4	2	2	4	..	..

* No or few inflammatory cells.

Changes of the vitreous consisted of fine deposits which resembled scintillatio and which diminished greatly in number during the period of observation of two months. They were mostly iridescent and transparent, sometimes opaque white and occasionally pigmented. Like the opacities in the lens, they did not interfere with the ophthalmoscopic examination of the eyeground. The second type of change in the vitreous was seen as clouds of opacities of varying density, which prevented the examination of the fundus for the first few weeks. After they had cleared in part, a circumscribed opaque mass was frequently visible in the lower peripheral portion of the vitreous and was generally resorbed in the following weeks. In 3 eyes dense strands were formed, however, which did not

Local areas of retinal atrophy, the size of about 1 disk diameter, were observed in a few eyes. Since they were similar to areas noted after the injection of penicillin without infection, they probably were caused by the proximity of the penicillin depot to the retina. In other eyes the residue of cellular exudate on the surface of the retina had produced proliferation of the neuroglia, followed by atrophy of the retina. Traumatic damage of the retina by the needle was found in 2 eyes and consisted of tears and a circumscribed retinal detachment. A flat, localized retinal detachment around the optic nerve in 2 eyes was attributed to the treatment with two injections. The uvea was normal except in 2 eyes, in which scattered foci were seen in the choroid.

Comment.—The experiments on the therapeutic effect of intravitreal injections of penicillin and sulfacetimide were limited to an exogenous infection with a mannitol-positive strain of Staph. aureus of average susceptibility to penicillin. No systemic therapy was applied because of the almost complete failure of the oral administration of sulfadiazine in treatment of various experimental exogenous infections of the anterior segment of the eye [23] and because of the unavailability of penicillin in the quantity necessary for systemic therapy.

Consistent standard lesions were obtained with the technic described. All the control eyes were lost, although the inflammation sometimes ran a fulminant course and sometimes developed gradually (four to seven days) to the clinical picture of an abscess of the vitreous.

The extremely favorable results of penicillin treatment begun within twelve to thirteen hours after inoculation are clearcut, since, without exception, all eyes were saved. The larger inoculum which was injected in four of the six hour experiments did not change the effect of the treatment. A single injection of the solution of penicillin was as beneficial as two injections followed by iontophoretic treatment of the anterior segment and caused considerably less reaction.

The treatment failed almost completely with an interval of twenty-four hours between inoculation and the first injection.

Untreated eyes removed thirty hours after infection showed histologically dense leukocytic infiltration and disarrangement of the retina, as well as an exudative retinal detachment. The extensive destruction in this brief period is certainly a factor in the inefficacy of local penicillin treatment begun twenty-four hours after inoculation. It cannot be decided from these experiments with acute infections, however, whether the active maturation of the bacteria also played a part, as may be expected in view of the in vitro experiments of Hobby and her coworkers.[24]

A purified penicillin preparation of high potency was used in all experiments because of its lower toxicity as compared with crude preparations. Although infections with only one strain of Staph. aureus were studied, there is a good basis for the prediction of a similar effectiveness of early penicillin therapy of exogenous infections of the vitreous with other organisms susceptible to the inhibitory action of penicillin. Since most strains of Staph. aureus, hemolytic streptococcus and D. pneumoniae are highly sensitive to the antibacterial activity of penicillin, a large majority of the exogenous intraocular infections present a promising field for local penicillin therapy.

Disappointing results with intravitreal injection of a 10 per cent solution of sodium sulfacetimide were obtained with infections with only one strain of Staph. aureus. No general conclusions should be drawn, therefore, in regard to the efficacy of the treatment for infections with other strains. The inflammatory reaction following the injection of this solution was, on the other hand, considerably greater than that after the injections of penicillin, and more caution would be required in its use.

It may be concluded from this experimental study that a single intravitreal injection of a purified potent penicillin is a reasonably safe procedure and that its application is justified in treatment of exogenous infections of the vitreous. The use of supplementary treatment, such as mydriatics, heat or fever or shock therapy, is advised in cases of infections of the vitreous of the human eye in order to increase the cellular and humoral body defenses, to hasten the resorption of the exudate and to prevent complications. The combination with immunotherapy, as pointed out by Thygeson,[25] may be useful with some infections. When the anterior segment is also involved, iontophoresis with penicillin can be combined with intravitreal injection of the drug. Systemic treatment should be added if the infective process has spread to the richly vascularized structures of the eye.

SUMMARY

1. A single injection of 0.2 cc. of a solution containing 2.5 mg. of sodium penicillin per cubic centimeter into the vitreous of rabbits secured a bacteriostatic activity of the vitreous fluid for more than twenty-four hours.

2. A single injection of 0.2 cc. of a 10 per cent solution of sodium sulfacetimide led to a high concentration of the sulfonamide compound in the vitreous and a lower concentration in the aqueous. The level of the substance in the vitreous was found to be close to 15 mg. per hundred cubic centimeters seventy-two hours after the injection.

23. von Sallmann, L.: Penicillin and Sulfadiazine in the Treatment of Experimental Intraocular Infections with Staphylococcus Aureus and Clostridium Welchii, Arch. Ophth. **31**:54 (Jan.) 1944; footnote 4.

24. Hobby, G.; Meyer, K., and Chaffee, E.: Observations on the Mechanism of Action of Penicillin, Proc. Soc. Exper. Biol. & Med. **50**:281, 1942. von Sallmann.[4]

25. Thygeson, P.: Sulfonamide Compounds in Treatment of Ocular Infections, Arch. Ophth. **29**:1000 (June) 1943.

3. The damage to the inner structures of the eye attributable to the injected purified preparation of penicillin was limited in general to a slight inflammatory reaction, without integral lesions of the retina, lens or vitreous. In several instances, however circumscribed atrophy of the retina was noted, probably caused by the proximity of the penicillin depot. The lesions were more pronounced on injection of a relatively crude preparation of penicillin.

4. The damage produced by repeated intravitreal injection was considerable and consisted occasionally of permanent lesions of the retina or the lens.

5. The irritation following the injection of sulfacetimide was usually greater and more prolonged than that following the injection of penicillin.

6. A reliable standard infection of the vitreous leading to phthisis bulbi was produced by the intravitreal injection of 0.05 cc. of a broth culture of Staph. aureus in a dilution of 10^{-5}.

7. The infection was checked in all instances by penicillin when it was injected into the vitreous six or twelve hours after the inoculation. The treatment was only of slight benefit when initiated twenty-four hours after inoculation.

8. The infection was not influenced by the intravitreal injection of sodium sulfacetimide administered six hours after the inoculation.

Miss C. Zink did most of the histologic technic.

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SIMULTANEOUS LOCAL APPLICATION OF PENICILLIN AND SULFACETIMIDE

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Many species of bacteria pathogenic to the eye are susceptible to the newer chemotherapeutic agents—both to sulfonamide compounds and to the products of molds; a few (Bacillus pyocyaneus, Morax-Axenfeld diplobacillus, Haemophilus influenzae and Friedländer's bacillus) are susceptible only to sulfonamide compounds. The degree of sensitivity of the species of the infecting organism to the drugs is but one of a number of factors which influence the therapeutic result. Also of importance are initial differences in sensitivity of strains of the same species to the selected compound and subsequent differences developing during the period of treatment, due in part to the maturation of the bacteria. Other factors are the number and the virulence of the infecting organisms, the amount of protein breakdown products or pus and the quality of the cellular and humoral body defenses. Some of these factors cannot be evaluated at all, and others require time-consuming tests. In view of the many unknown factors and because of the difference in the mechanism of the antibacterial action of sulfonamide compounds and that of mold products, a study of a combined local treatment with penicillin, as the most promising mold product, and a sulfonamide compound was indicated. The conditions present in acute intraocular infections suggest the usefulness of such a treatment, inasmuch as the bacteriologic diagnosis is frequently uncertain and the prognosis unfavorable in the event of a delay in the treatment.

EXPERIMENTAL STUDY

Preliminary experiments were related to the compatibility of penicillin and sulfonamide compounds in vitro, and specifically to the effect of the sulfonamide compounds on the bacteriostatic action of the labile penicillin. The activity of the penicillin [1] was determined according to the dilution method of Fleming [2]; an eighteen hour broth culture of Diplococcus pneumoniae, type III, in 10^{-1} dilution was used as the test culture. Appropriate dilutions of penicillin were made in parallel series, and to each tube was added an equal amount of the test culture. After incubation at 37 C. for twenty-four hours, the tubes were examined for inhibition of growth of the culture, and the amount of penicillin was calculated on the basis of the highest dilution in which growth was inhibited. To each tube of another parallel series was added sodium sulfadiazine in concentrations of 1 : 1,000 to 1 : 10,000. It was found that in all series growth of the culture was inhibited by 0.25 micrograms per cubic centimeter of the penicillin preparation used. The addition of sulfadiazine did not have any antagonistic effect on the inhibitory activity of the penicillin. In further in vitro experiments, sodium sulfacetimide was added in a concentration of 5 per cent to the usual solution containing 0.25 microgram per cubic centimeter of sodium penicillin, and no difference was noted in the antibacterial action of the penicillin. The effects of penicillin on the antibacterial action of sulfonamide compounds was not examined in this study, since the experiments of Hobby [3] have shown that penicillin does not exert an antisulfonamide action.

The next part of the study was concerned with the iontophoretic application to rabbits' eyes of a solution containing penicillin and a sulfonamide compound and the quantitative determination of these substances in the aqueous. Morisot,[4] Erlanger,[5] Brecher [6] and others recommended

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1. The penicillin was extracted and prepared in the laboratory of Dr. Karl Meyer.

2. Fleming, A.: In-Vitro Tests of Penicillin Potency, Lancet **1**:732, 1942.

3. Hobby: Personal communication to the author.

4. Morisot: L'iontothérapie en thérapeutique oculaire, Clin. opht. **32**:77 and 499, 1928.

5. Erlanger, G., and Erlanger, A.: Behandlung der Lederhautentzündung mit Calcium-Adrenalin bzw. Histamin-Iontophorese, Klin. Monatsbl. f. Augenh. **88**: 93, 1932. Erlanger, G.: Elektrische Einverleibung von Pharmaka ins Auge, Jahresk. f. ärztl. Fortbild. **23**:22, 1932.

(Footnote continued on next page)

the simultaneous iontophoretic introduction of two or more ionisotropes into the eye, but to my knowledge no quantitative estimations were made to establish the rationale of the procedure. In the present experiments a solution containing 2.5 mg. per cubic centimeter of sodium penicillin [7] and 5 per cent sodium sulfacetimide or 5 per cent sodium sulfadiazine was applied for five minutes at 2 milliamperes, with the use of local anesthesia induced with nupercaine hydrochloride. After one hour the aqueous was withdrawn from the identically treated eyes of single rabbits and pooled. Two-tenths cubic centimeter was used in each of two parallel series for the calculation of penicillin according to activity tests. The remainder was used for the colorimetric determination of the sulfonamide compound according to the method of Bratton and Marshall.[8]

TABLE 1.—*Activity of Penicillin and Concentrations of Sulfacetimide in the Aqueous of Rabbits Forty-Five to Sixty Minutes After the Iontophoretic Application of Sodium Penicillin, Sodium Sulfacetimide and a Solution of Both* *

Iontophoretic Application of	Activity of Penicillin, Expressed in Terms of Dilution of Aqueous Able to Inhibit Growth of D. Pneumoniae, III, 10^{-1}	Concentration of Sulfacetimide in Aqueous, Mg./100 Cc.
Sodium penicillin, 2.5 mg./cc.	1:64 1:64 1:64 Average, 1:64	
5% sodium sulfacetimide	.....	35.2 29.7 46.9 48.4 Average, 40.1
Solution containing 2.5 mg./cc. of sodium penicillin and 5% sodium sulfacetimide	1:48 1:64 1:64 1:44 Average, 1:55	36.0 42.6 35.9 52.5 Average, 41.8

* Each solution was applied for five minutes with a current of 2 milliamperes. Local anesthesia was induced with nupercaine hydrochloride.

The concentration in the aqueous after the iontophoretic application of the solution containing the two compounds was compared with the concentrations obtained with a solution of sodium penicillin alone, sodium sulfacetimide alone and sodium sulfadiazine alone,[9] introduced by a similar technic. As table 1 shows, the concentrations after the simultaneous introduction of penicillin and sulfacetimide approach those found in the aqueous after iontophoresis of a simple solution of penicillin or of sulfacetimide. The slight differences of the relative figures are within the limits of error of the quantitative methods. On the other hand, the figures for the concentration of sulfadiazine in the aqueous (not given in the table) after the application of a solution containing the sodium salts of sulfadiazine and of penicillin were significantly lower (25 mg. per hundred cubic centimeters) than the values after the application of sodium sulfadiazine alone (more than 40 mg. per hundred cubic centimeters). The explanation for the difference is seen in the precipitation of the free sulfadiazine acid at the p_H of the solution of sodium penicillin.

The eyes, especially the corneas, of the rabbits were examined for signs of irritation or damage which could be attributed to the application of the mixture. A transient haze of the corneal epithelium was frequently present—similar to that seen after the application of penicillin alone.[10] Human eyes with intraocular infections were also treated with a mixture of sodium penicillin and sodium sulfacetimide for five minutes at 2 milliamperes at intervals of twenty-four hours over a period of three to five days, without untoward effect.

TABLE 2.—*Results of Penicillin, Sulfadiazine and Penicillin-Sulfacetimide Treatment, Beginning Six Hours After Injection of a 10^{-4} Dilution of Staph. Aureus into the Anterior Chamber, with Simultaneous Injury of the Lens*

Treatment	No. of Eyes	Recoveries	Losses
Sodium penicillin iontophoresis..	12	9	3
Sodium sulfadiazine iontophoresis and oral use of sulfadiazine	12	1	11
Sodium penicillin and sodium sulfacetimide iontophoresis and oral use of sulfadiazine.....	12	9	3
Control eyes—no treatment.....	9	0	9
Control eyes—influenced only by oral use of sulfadiazine.....	15	0	15

The last part of the investigation dealt with the comparative effect of three types of therapy on a staphylococcic endophthalmitis produced in chinchilla rabbits. A 10^{-4} dilution of a twenty-four hour broth culture of a mannitol-positive Staphylococcus aureus was used, and 0.05 cc. was injected into the anterior chamber after extensive damage to the lens with the needle. The three types of therapy, applied six hours after the inoculation and repeated over a period

6. Brecher, L.: Ueber eine neue kombinierte Anwendungsweise der Dielektrophorese am Auge zwecks Erzielung einer wirksameren und tieferen Ionenpenetration, Klin. Monatsbl. f. Augenh. **97**:399, 1936.

7. Although actual titrations by the Oxford method were not made, 1 cc. of the solution was estimated to contain approximately 1,000 Oxford units.

8. Bratton, A. C., and Marshall, E. K., Jr.: A Coupling Component for Sulfanilamide Determination, J. Biol. Chem. **128**:537, 1939.

9. von Sallmann, L.: Sulfadiazine Iontophoresis in Pyocyaneus Infection of Rabbit Cornea, Am. J. Ophth. **25**:1292, 1942.

10. von Sallmann, L.; Meyer, K., and Di Grandi, J.: Penetration of Penicillin into the Eye, Arch. Ophth. **31**: 1 (Jan.) 1944.

of five days, were as follows: (1) iontophoresis with penicillin; (2) iontophoresis with sulfadiazine and oral use of sulfadiazine, and (3) iontophoresis with a mixture of the sodium salts of penicillin and sulfacetimide combined with the oral administration of sulfadiazine.

The results of the various treatments are compared in table 2. Nine out of 12 eyes were saved by local penicillin therapy. The infection was checked in only 1 out of 12 eyes treated locally and systemically with sulfadiazine. The combined local treatment with penicillin and sulfacetimide, supplemented by the systemic administration of sulfadiazine, was effective in 9 out of 12 eyes.

The experiments with intraocular infections produced by one strain of Staph. aureus showed that the efficacy of local penicillin therapy was not increased by its combination with topical application of sulfacetimide, supplemented by systemic administration of sulfadiazine. It must be emphasized, however, that there are great differences in the sensitivity of strains of Staph. aureus to sulfonamide compounds. No general conclusions should be drawn from these experiments, therefore, in regard to infections with other strains of Staph. aureus or with other species. More favorable response to the combined treatment, exceeding that to local penicillin therapy, can certainly be expected in infections with strains of greater susceptibility to the sulfonamide compounds. In conformance with this opinion, a few patients with intraocular infection were treated in the Presbyterian Hospital. The doubtful cause of their infection and the urgency of early treatment favored the selection of this type of therapy. The number of patients is too small, however, to permit any conclusions.

SUMMARY

1. Sulfadiazine and sulfacetimide do not exert any noticeable antagonistic effect on the bacteriostatic activity of penicillin in vitro.

2. Approximately the same concentrations of penicillin and sulfacetimide are found in the aqueous of rabbits after the iontophoretic application of a solution containing both their sodium salts as after the iontophoretic application of a solution containing the respective salt.

3. Topical treatment with penicillin and sulfacetimide, supplemented by systemic administration of sulfadiazine was not more effective than local penicillin therapy in the treatment of an experimental intraocular infection with one strain of Staph. aureus.

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LOCAL VERSUS SYSTEMIC PENICILLIN THERAPY OF RABBIT CORNEAL ULCER PRODUCED BY GRAM-NEGATIVE ROD

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PHILADELPHIA

In evaluating any chemotherapeutic agent against infection in vivo, one has to determine the best method of administration for the anatomic site involved. In treatment of corneal infections with penicillin two main routes of administration are available, local application to the cornea and systemic administration.

Two methods of obtaining information concerning the routes of administration in experimental animals allow one to predict the results to be expected in human beings. Both methods are essential. The first is to determine the concentration reached in the cornea by the various means of administration; the second is to compare the effects of the methods against a standard lesion. No one has measured the concentration of penicillin in the cornea produced by either local or systemic use. The present biologic methods of estimating the concentration of the drug make such a determination in corneal tissue most difficult. It was our purpose in this study to compare the effect of application of local penicillin with that of intramuscular administration of the drug against a standard ocular infection. The local method chosen for this study was that of application of drops of a solution of penicillin at frequent intervals. Of the various local procedures tested by von Sallmann [1] for obtaining levels of penicillin in the aqueous, drop instillation gave the lowest concentration in the aqueous; therefore this method was chosen in order to make the comparison fairer. The intramuscular route of systemic administration was selected for this study because it is the most practical for systemic use.

During routine cultures of material from the cul-de-sacs of rabbit eyes a gram-negative bacillus was repeatedly obtained. When this organism, isolated in pure culture, was injected into the rabbit cornea, a characteristic ulcerative lesion was regularly produced.

The cultural and biochemical reactions of the organism correspond in some respects to those of the Friedländer group. However, Dr. Louis Julianelle, in a detailed examination of the organism, found that it was not in the Friedländer–Klebsiella rhinoscleromatis group. As far as we have been able to determine, it is a bacterium which has not been previously described. It is a nonmotile, gram-negative rod, which forms an elevated, moist colony. Surface growths on agar may become confluent, and the condensation water of an agar slant becomes mucoid. After two or three days' growth the colonies undergo a radical change in appearance, becoming flat and dry. Dextrose, but not lactose, is fermented without gas, and nitrate is reduced. Infusion broth will not support growth of the organism unless enriched with neopeptone, or, preferably, with dextrose or lactose. A more complete description of the organism will be the subject of a future paper.

Sensitivity tests, with use of the "well" method,[2] showed that this organism is sensitive to the action of penicillin but requires fifty times as much penicillin for inhibition as does a strain of Staphylococcus aureus of average sensitivity.

With the demonstration of sensitivity of this gram-negative organism to penicillin in vitro, it was desirable to determine whether the sensitivity existed in vivo. For these experiments it was possible to utilize the ulcerative lesion of the rabbit cornea mentioned.

THE STANDARD OCULAR LESION

Blue-eyed chinchilla rabbits, weighing 2 to 3 Kg., were used. It was found that intracorneal injection of a diluted twenty-four hour dextrose broth culture of this organism produced a severe infiltration, with vascularization, of the cornea and hypopyon. By regulation of the number of organisms injected, lesions of varying degrees of severity could be produced. Injection of sterile dextrose broth alone in control eyes produced only an area of localized edema, which disappeared approximately forty-eight hours later.

For the experiments reported here, a twenty-four hour dextrose broth culture of the organism was diluted

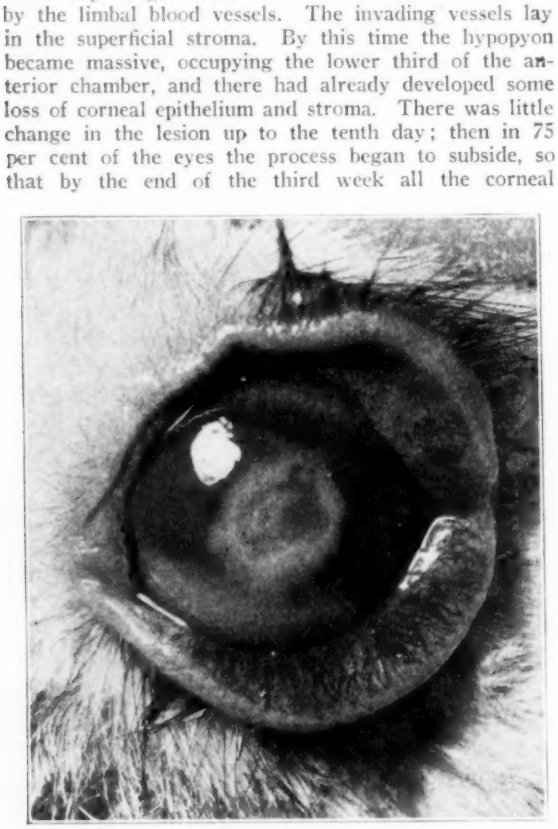
From the Department of Ophthalmology and the Harrison Department of Surgical Research of the University of Pennsylvania.

The work described in this paper was done under a contract, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the University of Pennsylvania.

1. von Sallmann, L.; Meyer, K., and Di Grandi, J.: Penetration of Penicillin into the Eye, Arch. Ophth. **31**:1 (Jan.) 1944.

2. Fleming, A.: In-Vitro Tests of Penicillin Potency, Lancet **1**:732, 1942.

one hundred times with sterile isotonic solution of sodium chloride, and 0.02 cc. of the diluted culture was injected intracorneally. Culture counts showed that this provided approximately 400 organisms per injection. Within twenty-four hours such an injection produced a localized area of corneal edema and infiltration, pericorneal injection and aqueous flare and floaters. In forty-eight hours the infiltrated area was denser and larger and the pericorneal injection greater, and pus cells began to collect in the angle of the anterior chamber. The lesion increased in severity gradually. By the sixth day large areas of the cornea were invaded by the limbal blood vessels. The invading vessels lay in the superficial stroma. By this time the hypopyon became massive, occupying the lower third of the anterior chamber, and there had already developed some loss of corneal epithelium and stroma. There was little change in the lesion up to the tenth day; then in 75 per cent of the eyes the process began to subside, so that by the end of the third week all the corneal



Standard ocular lesion, seven days old, showing hypopyon, vascularization and ulceration of the cornea.

vessels had disappeared. The pericorneal injection had subsided; epithelium covered the defect in the cornea, and the area of opacification became less dense. The remaining 25 per cent of the eyes went on to perforation and loss of function. Cultures of material from the infiltrated areas taken at the end of seventy-two hours were positive for the gram-negative organism in 100 per cent of the control eyes. The figure shows a lesion as it appeared on the seventh day.

INFLUENCE OF PENICILLIN THERAPY

The penicillin used in these studies had a potency of approximately 200 units per milligram and was obtained from the Committee on Medical Research, through Dr. Chester S. Keefer.

Fifteen rabbits were used in this series. Approximately 400 organisms (0.02 cc. of a twenty-four hour culture in dextrose broth, diluted one hundred times with sterile isotonic solution of sodium chloride) was injected into the cornea of each eye. Two hours after injection the right eyes of the first 12 rabbits received penicillin locally; the left eyes of the same 12 rabbits were given no therapy. The concentration of penicillin was 500 units per cubic centimeter. The penicillin was diluted in sterile isotonic solution of sodium chloride, and 3 drops (approximately 0.25 cc.) was applied to the cornea and cul-de-sac every hour, the applications starting at 11 a. m. and continuing until 10 p. m., when therapy was stopped. Treatment was started again at 9 a. m. the next day, and the penicillin was applied every hour until 10 p. m. On the third day the penicillin was instilled only four times in twenty-four hours, and its administration was then discontinued entirely.

The remaining 3 rabbits received penicillin intramuscularly, the injections being started two hours after injection of the culture into both eyes. A dose of 250 units of penicillin per kilogram of body weight was injected into the gluteal region of each rabbit. Injections were made every two hours until 12 p. m., the treatment starting again at 8 a. m. the next morning. This therapy was continued for three days, and the injections were then reduced to one every four hours for two more days, when treatment was stopped.

All the eyes were examined daily with the aid of a biomicroscope. Material for culture was taken from all the eyes seventy-two hours after injection and then daily, at 8 a. m., after the lull in therapy.

RESULTS

Experiment 1.—At the end of seventy-two hours cultures were positive for the gram-negative bacillus for all untreated eyes and for all 6 eyes of the rabbits treated by intramuscular injection. Corresponding cultures were negative for 10 of the locally treated eyes, and one colony resulted from culture of material from each of the remaining 2 eyes.

Clinically, each one of the untreated, control eyes displayed a course of events similar to that of the standard lesion. The lesions in all 6 eyes of the rabbits given intramuscular injections of penicillin followed the same course as did the standard lesion. In none of the 12 eyes treated by local instillation of penicillin did corneal infiltration, corneal vascularization, aqueous flare and floaters or corneal slough develop. At the end of twenty-four hours one could discern only the point of the needle puncture and localized edema in these eyes. In 8 eyes a minute spot or haze could still be made out with the biomicroscope at the site of injection at the end of the first week. These spots gradually reduced in size, so that they were barely perceptible, even by corneal microscope, at the end of two weeks. The corneas of the remaining 4 locally treated eyes were entirely clear by the fifth day.

Experiment 2.—With 15 rabbits penicillin therapy was delayed twenty-four hours after injection of the culture into the cornea.

The same technic was used as in experiment 1. However, here 0.02 cc. of a twenty-four hour dextrose broth culture, diluted 1:100, contained approximately 10,000 organisms. Therapy was

not started until twenty-four hours after inoculation but was applied on the same time schedule as in experiment 1. Twelve rabbit eyes received local therapy, the other eye of each rabbit acting as the control, and 3 rabbits received intramuscular therapy.

In all eyes, both treated and untreated, there had developed corneal edema, corneal infiltration, pericorneal injection and aqueous flare and floaters at the end of twenty-four hours. In seventy-two hours the lesions were pronounced. However, after seventy-two hours the locally treated eyes showed a definitely smaller area of infiltration, less corneal edema and smaller collections of cells in the anterior chamber, and in 6 of the locally treated eyes hypopyon did not develop. The cornea in all eyes was invaded by vessels, the locally treated eyes showing a smaller amount of vascularization. By the second week the locally treated eyes were distinctly better than the control eyes in that the areas of infiltration were decreased, corneal edema had largely subsided and many of the vessels were disappearing. In four weeks 10 of the untreated eyes had perforated, while all of the locally treated eyes remained intact. By this time the lesions of the locally treated eyes had subsided with large scars, the cells in the anterior chamber having been completely absorbed and the vessels having disappeared. In only 2 of the control eyes did the process subside. The process in the eyes of the rabbits treated intramuscularly ran practically the same course as did that in the control eyes, no significant difference being discernible.

COMMENT

The experimental data show that this gram-negative organism, obtained by routine culture of material from the conjunctival cul-de-sacs of rabbit eyes, is sensitive to penicillin in vitro. The experiments demonstrate that this organism can produce a corneal lesion when injected intracorneally. The development of this corneal lesion can be prevented by the use of local penicillin but not by intramuscularly administered penicillin. Once the lesion is established, local penicillin therapy benefits the course of the lesion but does not prevent the occurrence of considerable ocular damage. Intramuscularly administered penicillin does not appear to alter significantly the course of the lesion when therapy is started twenty-four hours after injection.

It is evident that longer-continued therapy might have produced better results. It is possible also that intramuscular therapy would have been successful if the treatment schedule had not been interrupted for eight hours. However, local therapy, which did benefit the lesion, was interrupted for a similar interval.

It must be stressed that this observation of the superiority of local over systemic treatment applies only to corneal infection and should not be construed to apply to infections of other ocular structures.

Attempts to improve the results by including a detergent, such as duponol ME Dry [2a] 0.4 per cent, in the penicillin preparations had to be discontinued because repeated application of the detergent in this concentration was damaging to the cornea..

Although, as a rule, gram-negative rods are insensitive to the action of penicillin, a few species are moderately susceptible, and still others exhibit a slight degree of sensitivity. Abraham and coworkers [3] showed that Salmonella gärtneri was inhibited by a 1:20,000 dilution, and Salmonella typhi by a 1:10,000 dilution, of a solution of penicillin which inhibited a culture of Staph. aureus when diluted 1:1,000,000.

In the experience of Fleming [4]; Hobby, Meyer and Chaffee [5]; McKee and Rake,[6] and of this laboratory, members of the Friedländer group of bacilli have been insensitive to penicillin. However, Smith [7] showed that variation in strains is remarkable in this group, and the sensitive strains which he encountered included some of type A. A similar situation was reported by Churchman [8] in that among gram-negative rods, on the whole insensitive to the action of methylrosaniline chloride, an occasional sensitive strain may be encountered.

CONCLUSION

Local application of penicillin proved to be more effective than intramuscular administration in the treatment of corneal infections due to a gram-negative bacillus. The organism was sensitive to the drug in vitro and in vivo, as determined by the "well" method of Fleming and associates.

2a. Duponol is a registered trademark designating certain higher aliphatic alcohol sulfates and their derivatives which are used as detergents. Duponol ME dry is derived from technical lauryl alcohol and contains a minimum of electrolytes.

3. Abraham, E. P., and others: Further Observations on Penicillin, Lancet **2**:177, 1941.

4. Fleming, A.: The Antibacterial Action of Cultures of a Penicillium, with Special Reference to Their Use in the Isolation of B. Influenza, Brit. J. Exper. Path. **10**:226, 1929.

5. Hobby, G. L.; Meyer, K., and Chaffee, E.: Activity of Penicillin in Vitro, Proc. Soc. Exper. Biol. & Med. **50**:277, 1942.

6. McKee, C. M., and Rake, G.: Biological Experiments with Penicillin, J. Bact. **42**:645, 1942.

7. Smith, L. D.: The Bacteriostatic Agent of Penicillin Chrysogenum, J. Franklin Inst. **254**:396, 1942.

8. Churchman, J. W.: Further Studies on Behavior of Bacteria Toward Gentian Violet, J. Exper. Med. **33**: 569, 1921.

TREATMENT OF OCULAR TUBERCULOSIS

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DULUTH, MINN.

The treatment of ocular tuberculosis perhaps dates from 1855, when, according to Duke-Elder,[1] Jaeger, through the use of the ophthalmoscope, observed the occurrence of choroidal foci in conjunction with miliary tuberculosis. The subsequent evolution of methods of examination, in particular the inauguration of tests with tuberculin and roentgenographic examination of the intrathoracic organs, as well as the promulgation of the doctrine of immunity and the possibility of the microscopic exploration of the anterior segment of the eye in vivo with the aid of the slit lamp, devised by Gullstrand,[2] represented important additions to the knowledge of tuberculous diseases of the eye. Goldenburg [3] stated the belief that the discovery of tuberculin by Koch, in 1891, exerted a profound influence on ophthalmologic practice, although the indiscriminate application of tuberculin led to the abuse and consequent repudiation of its use.

During the past ten years notable advances have been achieved in the general therapy of tuberculous diseases of the eye, chiefly through administration of the several preparations of tuberculin now available for the purpose and through the employment of vaccines and antigens, autohemotherapy, the use of gold salts, phototherapy and the institution of sundry more or less empiric forms of treatment.

Previously, treatment with tuberculin was utilized less frequently, perhaps in consequence of the insistence on its employment only with carefully selected patients and of the restrictions in the manner and extent of its application. The scope of vaccinotherapy was amplified because it was often substituted for the more conventional methods of specific treatment. The progress of antigenic therapy, likewise, served in large measure to replace tuberculin therapy. Autohemotherapy acquired enthusiastic advocates. Although opinions concerning the value of chrysotherapy were divided, on the whole they were favorable. Phototherapy and radiotherapy once more demonstrated their superior merit in appropriate instances. The results from various tentative procedures, as recorded, failed to afford adequate criteria for judgment of their therapeutic virtue.

It has been demonstrated repeatedly that the uvea constitutes a particularly favorable nidus for the accidental localization of tubercle bacilli and the subsequent induction of a state of sensitization, presumably because of the prevalence therein of elements of the reticuloendothelial system. In the opinion of many foreign authorities, based on the experimental production of violent local ocular reactions by the injection of tuberculin into previously sensitized subjects, virtually every type of iritis, iridocyclitis and choroiditis is of conceivable tuberculous origin. These observers accept the reactions elicited as incontrovertible evidence of the tuberculous nature of the uveitis. As a matter of fact, Lagrange,[4] in his classic monograph on tuberculous iridocyclitis, asserted categorically that when biopsy is impracticable, the diagnosis of tuberculosis can be established definitely by means of the focal reaction to tuberculin alone. Moreover, he declared that tuberculous infection of the eye may manifest itself occasionally under the aspect of a common diffuse iritis, without specific lesions in the form either of nodules or of tuberculoma. Although certain other authors have described diffuse parenchymatous iritis as the initial stage of a disease which finally develops into the nodular, and thence into the tuberculomatous, variety, Lagrange [4] insisted that this iritis may never deviate from its ordinary inflammatory character.

Prominent among the opponents of the view set forth is Williamson-Noble,[5] who showed that tuberculous toxins apparenty do not possess the absolute specificity attributed to them. Incidentally, through his tentative essays with the empiric application of tuberculin therapy in cases

1. Duke-Elder, W. S.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1940, vol. 3, p. 2295.

2. Gullstrand, cited by Schieck, F.: Tuberkulöse Infektion und Augenleiden, Leipzig, Johann Ambrosius Barth, 1932.

3. Goldenburg, M.: Ophthalmic Tuberculosis, in Goldberg, B.: Clinical Tuberculosis, ed. 2, Philadelphia, F. A. Davis Company, 1939, vol. 1, p. 83.

4. Lagrange, H.: Etudes ophthalmologiques: La tuberculose de l'iris et du corps ciliare, Paris, Gaston Doin & Cie, 1933, vol. 4.

5. Williamson-Noble, F. A.: Brit. J. Ophth. **16**:285, 1932.

Fig. 1.—Growth through the base of the iris.

of supposedly nontuberculous disease of the eye, this investigator obtained extraordinarily successful results, and so confirmed the observations of Wright [6] and others to the effect that tuberculin in the form of a bacillary emulsion represents an excellent antigen for employment against staphylococcic infections. In a contribution on the tubercle bacillus as a cause of obscure disease of the eye, published several years later, Williamson-Noble [7] cited the protocols of experiments conducted by Finnoff [8] which tended to cast doubt on the specific character of the tuberculin reaction in cases of spontaneous uveitis of suspectedly tuberculous origin (Moore [8a]).

Duke-Elder [9] expressed the belief that the disrepute incurred by the method of treatment of ocular tuberculosis with the various preparations of tuberculin should be ascribed in great part to the fatal consequences of the administration of moderately large doses with the object of eliciting successive focal reactions and of inducing thereby a local immunity. He stated that it is probable that optimal results are obtainable only if tuberculin is considered merely as a means for the production of a period of desensitization sufficiently protracted to inhibit allergic activity and thus to permit the establishment of an immune state. Hence, he concluded that tuberculin therapy should be regarded not as a curative expedient but as an adjuvant to the indispensable general treatment of uveal tuberculosis.

The following clinical observations have certain unusual features which characterize each of them. One relates to a malignant case of tuberculous iridocyclitis in which enucleation of the globe, performed to prevent extension of the process to the meninges, rendered it possible to secure material for a detailed demonstration of the pathologic changes which occurred in the eye during the progress of the disease.

6. Wright, A., cited by Williamson-Noble.[5]

7. Williamson-Noble, F. A.: Brit. M. J. **2**:907, 1936.

8. Finnoff, W. C., Am. J. Ophth. **7**:81 (Feb.); 365 (May) 1924; cited by Williamson-Noble.[7]

8a. Moore, R. F.: Tr. Ophth. Soc. U. Kingdom, **55**:3, 1935.

9. Duke-Elder,[1] pp. 2315-2316.

REPORT OF CASES

This first case represents an active form of secondary, malignant, uncompensated tuberculous uveitis, as described by Werdenberg,[10] with an exceedingly high degree of toxic sensitivity. With this form of ocular tuberculosis the use of tuberculin is positively contraindicated because of the unfavorable state of sensitivity; hence, conservative general and local treatment are required.

R. J., a man aged 20, a farmer, was first seen on Jan. 13, 1941. At that time the right eye was inflamed and vision impaired. There was a slight palpebral discharge. Moderate injection of the ciliary processes was noted. Typical "mutton fat" deposits (keratitic precipitates) were discerned on the posterior surface of the cornea. A dark orange-reddish mass appeared to protrude through the base of the iris into the anterior chamber at 2 o'clock (fig. 1). Numerous recently formed blood vessels were seen on the surface of this mass and on the body of the iris. The fundus was not visible. The intraocular tension was low. Visual acuity was 5/100 in the right eye and 2/26 in the left eye. With glasses, supplied by an optician, vision in the left eye was improved to 20/25.

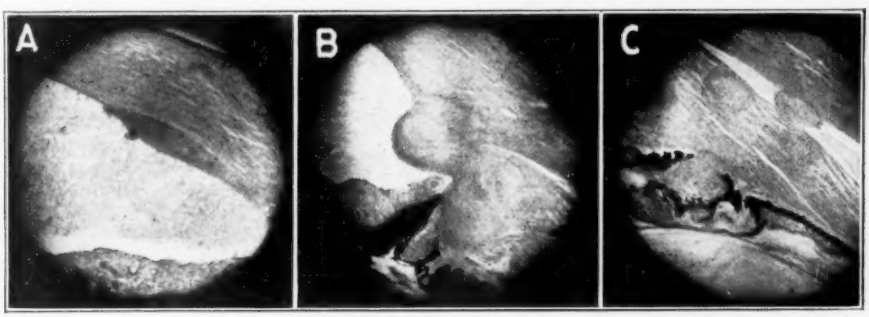

Fig. 2.—*A*, tubercle under Descemet's membrane, near the attachment of the pectinate ligament; *B*, conglomerate tubercle, extending into the anterior chamber, and *C*, scattered tubercles in the ciliary body and one tubercle on the internal surface of the sclera.

Blood tests for typhoid and parathyphoid fever, brucellosis and tularemia, previously conducted by the family physician, had all given negative results, as had serologic tests, particularly the Wassermann and Kline tests. On the contrary, the Mantoux test gave a 2 plus reaction in seventy-two hours. Roentgenographic examination revealed two enlarged glands in the mediastinum. The lungs were normal.

The patient received three successive therapeutic applications of roentgen rays to the right eye, consisting of 37.5 r each, administered on January 18, January 25 and February 3 respectively, in conjunction with rest in bed and a diet rich in vitamin content. He was seen in consultation with Dr. Frank E. Burch on January 24. It was agreed that the patient had a

10. Werdenberg, E.: Klin. Monatsbl. f. Augenh. **87**: 1, 1931.

conglomerate tubercle of the iris. Subsequent examination with the slit lamp showed a number of extensive lardaceous deposits on the posterior surface of the cornea. The aqueous flare was evident. The iris was bound down by posterior synechiae. A small, clearly defined tumor, heavily vascularized, was present on the temporal side. No decrease in the size of the mass occurred during the fortnight which followed the final application of the roentgen rays. Meanwhile the vision had diminished to mere perception of light. Accordingly, after a second consultation with Dr. Burch on February 17, the affected eye was enucleated for fear that the process might extend to the meninges.

Pathologic Report (Dr. Beulah Cushman).—Macroscopic Examination: The bulb measured 24 by 24.5 by 24.5 mm. and was uniformly smooth (the optic nerve having been cut flush with the surface), but could not be transilluminated. The temporal segment measured 23 by 25 mm. and the nasal segment 15 by 17 mm. The vitreous humor was soft, creamy and of fair consistency. In the nasal segment the ciliary body presented throughout its pars plana three distinct areas of thickening, the color ranging from a grayish to a creamy tint. The retina and the choroid were in place.

Microscopic Examination: Cornea: Edema, with round cell infiltrations, was present. Vascularization in the upper nasal quadrant extended forward into the stroma. The endothelium was swollen, and many large mononuclear cells and macrocytes, in part isolated and in part clumped, adhered to it. The anterior chamber contained fine granular matter, through which mononuclear cells and small lymphocytes were disseminated. Identically similar granular matter was noted in the posterior chamber. Nodules composed of epithelioid cells, surrounded by a thin covering of small lymphocytes, protruded into the anterior chamber from the pectinate ligament at the periphery and in one section fig. 2*A*) displaced the membrane of Descemet forward from the anterior surface of the ciliary body and the root of the iris. In another section a giant cell was observed to extend from the vicinity of the pectinate ligament. The recesses of the angle were partly occluded by cellular infiltration of the pectinate ligament, as well as the membranes along the anterior surface, and the swollen iris.

Iris (fig. 2*B*): Edema and infiltration with plasma cells, small lymphocytes and disseminated Russell bodies were noted. A cellular membrane extended over the anterior surface and over clumps of cells composed of mononuclears, small lymphocytes and fibrin. The posterior layer of pigment was separated in certain areas and was adherent to the anterior capsule of the lens. Nodules consisting of small lymphocytes and epithelioid cells, which were present in the pigment layer, also adhered to the capsule. Here and there the layers of pigment were separated by the edema. In one section the iridic nodule was seen in the stroma immediately posterior to the sphincter on the left side, with nodules of small round cells adherent to the sphincter. Another section revealed a fine membrane which extended across the pupillary area and a nodule of epithelioid cells and lymphocytes which adhered to the capsule of the lens.

Ciliary body and processes: These structures were edematous, and large tuberculous nodules, consisting of small lymphocytes, epithelioid cells and an occasional giant cell, were present in the vascular portion of the ciliary body on the left side. In one section, six (fig. 2*C*) nodules were counted in the ciliary body, one at the edge, pushing up the pigment epithelium, and another adhering to the internal layer of the sclera (scleritis interna). Three smaller nodules, present in the unpigmented epithelium, produced dispersion and irregularity of the latter. A similar nodule was observed in one of the ciliary processes on the right side.

Lens: In most sections the lens appeared to have fallen out. The capsule was intact. Cellular deposits and a nodule, already described, adhered to the anterior capsule. In one section the posterior cortical fibers under the capsule on the right side were swollen. The posterior capsule of the lens and the condensation of the vitreous showed scattered large mononuclear cells.

Vitreous: The vitreous was converted into a delicate reticulum, containing scattered mononuclear cells derived from cellular precipitates over the flat portion of the ciliary body, and a nodule which apparently had broken into the vitreous.

Choroid: There was disseminated infiltration with small lymphocytes, and the pigment epithelium was separated from the rest of the choroid and was adherent to the retina.

Retina: In three sections, the retina was seen to be detached in the region of the macula, and also to be separated from the choroid, but entirely as an artefact, with the pigment epithelium adherent in many areas. The macular region was cystic, with spaces containing stained albuminous substance in the outer plexiform and nuclear layers. In one section a large cyst was observed in the fovea.

Sclera: Small lymphocytes had infiltrated the area of the limbus and the spaces around blood vessels. A large nodule, composed of lymphocytes and epithelioid cells, was encountered in the narrow space between the sclera and the ciliary body.

An anatomicopathologic diagnosis of tuberculous keratitis, iritis, cyclitis and scleritis interna (deep scleritis) was thereon established.

In this case, local treatment, rest in bed and a high vitamin diet were supplemented by roentgen irradiation. The tuberculous process failed to respond to treatment, and enucleation was advised and performed.

The following 3 cases illustrate tuberculous inflammation of the anterior segment. On entering a sanatorium, all the patients responded to treatment with rest in bed, a high caloric diet, abundantly supplied with vitamins, and tuberculin, administered in accordance with a carefully individualized plan of dosage. A second series of treatments, with tuberculin therapy distributed over a period of from one to two years, was advised for each of these patients as a safeguard against recurrence.

The 3 patients—H. W., aged 35; J. L., aged 12, and V. K., aged 20—came to the office within a period of one year and a half. Each had had the condition described from six weeks to three months prior to consultation. All had pain, lacrimation, photophobia, blurring and diminution of vision. V. K. had a history of snow blindness, experienced in February 1941. Mantoux tests made on H. W. and J. L. gave positive reactions.

From April until October 1941, H. W., who had a corneal ulcer on the right eye, was treated at the office. Silver nitrate was brushed on the eyelids; sulfanilamide powder was dusted into the cul-de-sac, and tincture of iodine was applied to the ulcer, which was also touched

with trichloroacetic acid. The local treatments afforded little relief. On Oct. 10, 1941 the patient was admitted to the sanatorium. Roentgenographic examination of the chest failed to reveal tuberculosis, but the Mantoux reaction was 3 plus. The patient was given a diet rich in vitamins and received old tuberculin in gradually enlarged doses twice a week until the initial dose of 0.001 mg had been increased to 1 mg. The corneal ulceration rapidly subsided, and the patient was soon relieved of his symptoms. The patient has experienced no recurrence of the ocular disease. Vision is now 20/25 in the right eye and 20/25 in the left eye.

J. L., when seen on May 4, 1940, had a corneal ulcer on the lower margin of the pupillary area of the right eye, with involvement of the stroma. Vessels extended to the margin of the ulcer, in the midthird of the stroma. The lesion was treated with mild cauterization and instillation of antiseptics into the eye. The depth of the ulcer increased progressively, until Descemet's membrane was exposed, with the possibility of herniation of the membrane. Dr. Archibald Olson placed a conjunctival flap over the area of the ulcer. The patient suffered from severe pain, and there was a terrific inflammatory reaction in the eye, with considerable haziness of the entire cornea and a purulent discharge from the eye. The sutures of the flap were cut, and sulfathiazole powder was insufflated in the eye every three hours. The discharge from the eye promptly decreased. The inflammatory reaction became less. By the end of ten days the ulcer had completely healed, with minimum corneal scarring.

Because of the presumed exposure to tuberculosis, a positive Mantoux reaction and the persistence of the ocular lesion on the right side, it was assumed that the ulcer was of tuberculous origin and, therefore might be benefited by desensitization to tuberculin; hence, treatment in a sanatorium was advised. At the time of the patient's admission to the institution, a roentgenogram revealed a considerably enlarged hilus on the left side of the chest. Old tuberculin was administered twice a week, the dose commencing with 0.0001 mg., and injections of 1, 1.5, 2.2, 3.2, 4.7, 6 and 10 cc. of a decreasing dilution were given until a dose of 0.1 mg. was attained. Thereon the patient received 0.1 mg. twice a week for fifteen weeks, without additional increase in the dose. She made a rapid recovery, and there has been no recurrence of her symptoms.

Examination of V. K. revealed an area of edema and increased thickening of all the layers of the cornea of the right eye. The sclera was injected. There was no vascularization of the cornea. Vision was 20/50 in the right eye and 20/20 in the left eye. At the sanatorium to which he was admitted, he was treated with rest in bed, and a 1 per cent solution of atropine sulfate was instilled into the right eye sufficiently often to keep the pupil widely dilated. A diet rich in vitamins was ordered, and subcutaneous injections of old tuberculin were administered at intervals of three days, the first dose being 0.001 mg. The lacrimation, photophobia and scleral injection rapidly subsided, with gradual diminution of the area of corneal opacity.

In the first 2 of these cases the condition was tuberculous keratitis of the relatively more frequent ulcerative type, and in the third case, mild tuberculous sclerokeratitis. A number of investigators have denied that the tubercle is a factor in the causation of inflammatory processes of the cornea and the sclera. However, in many cases the diagnosis of tuberculous keratitis is based on the clinical aspect alone or on the therapeutic response to tuberculin. This situation is attributable primarily to the fact that corneal tissue affords an exceedingly poor medium for the culture of the bacillus and thus renders difficult the study of tuberculous lesions of the cornea. Histologic studies reveal no specific difference in appearance between sclerokeratitis and scleritis in general; certain of the phenomena present suggested that the condition was tuberculosis.

In a fifth case, one of tuberculous choroiditis, observations were made at occasional intervals for approximately ten years, during which the patient was submitted to a number of different forms of treatment, including tuberculin therapy. However, she received no systematic treatment with tuberculin until the disease had become well established. Despite this fact, the subsequent improvement in her general condition was distinct. Tuberculosis was assumed to be the cause of the retinal hemorrhage which occurred in this patient, whose somewhat unusual history follows. The antecedent optic neuritis probably was due, likewise, to infection with the tubercle bacillus, and not to the causes assigned in the past history. This tentative etiologic hypothesis was supported by the result of the physical examination of the patient's chest.

S. M. P., a woman aged 26, when first seen on June 18, 1917, presented a history of two previous attacks of optic neuritis in the left eye, one about two years earlier and the other within the preceding month. The first attack had been attributed to a nervous breakdown from overwork and the second to abscessed teeth. An examination on the aforementioned date revealed a hemorrhage (presumably associated with a metastatic embolus) involving the inferior temporal artery on the left optic disk.

While attended by Dr. Frank Burch, the patient had received six injections of old tuberculin during September and October of 1917, the dosage not being recorded. The report of a roentgenographic examination, on Oct 11, 1917, revealed tuberculosis of the glands of the thorax, with extension to the apex of the right lung. At that time lesions were discovered on the retina near the optic nerve and along the internal temporal vessels. On the same day the patient was admitted to a sanatorium for one month's observation and inoculation with a tuberculoprotein vaccine (von Ruck). She remained under treatment from Nov. 21, 1917 to March 21, 1918. Beginning on Dec. 27, 1917, she received a subcutaneous injection of 0.001 mg. of old tuberculin. Tuberculin was administered in gradually increasing doses until Aug. 17, 1918, when a maximal dose of 8 mg. was attained.

After a lapse of nearly seven years, in the spring of 1925, the patient placed herself under the care of Dr. D. W. Wheeler, a tuberculographist. In a written communication to Dr. Wheeler, on March 14, 1925, Dr. Charles May, of New York, advised injections of tuberculin in minute doses every fourth or fifth day,

with gradual increase of the dose so as to avoid a reaction and continuation of the treatment from six months to one year. An initial dose of 1:40,000 dilution was recommended. Despite the fact that diagnostic tests with tuberculin had invariably given negative results when conducted on the patient, Dr. May expressed his conviction that the hemorrage which had been observed could be ascribed to tuberculous disease; hence the indication for the use of tuberculin. He added that even in the absence of a positive reaction to tuberculin, many ophthalmologists (including de Schweinitz) advocated the employment of injections of tuberculin.

Accordingly, an increasing series of treatments with old tuberculin, based on the foregoing scheme—0.10, 0.13, 0.15, 0.22, 0.25, 0.32, 0.47, 0.63 and 0.81 cc.—was instituted by Dr. Wheeler and continued from April 6 to July 26, 1925. Beginning on April 6, 1926, a second series of the same character was administered. The general condition of the patient was greatly improved by the systematic tuberculin therapy. The ocular lesion finally became quiescent. Meanwhile, the patient had lost the central vision of the affected left eye, owing to a lesion of the macula.

In January 1937 Dr. Burch suggested the employment of nonspecific protein therapy in the form of injections with typhoid-paratyphoid vaccine. He expressed the belief that the consequent leukocytosis would prove extremely efficacious during the regressive stage succeeding the period of exudation, and that the resultant temporary impairment of vision would affect only slightly the already seriously diminished visual acuity of the left eye, while the incidental phagocytosis would be likely to benefit the ocular condition.

Perhaps the most significant features of the ocular disease in the case described here were the exceedingly protracted interval which elapsed between the onset of the optic neuritis and the loss of central vision of the left eye, particularly in the absence of a history of the occasional temporary obscurations of vision which generally precede total blindness resulting from arterial obstruction. The observation serves, also, to illustrate the fallacy of recourse to tuberculin therapy unless the latter is instituted promptly and is continued at regular intervals.

The following 7 cases exemplify the difficulty encountered in prevailing on patients with ocular tuberculosis to continue the treatment with tuberculin and to report the final results of such treatment. The patients, who were seen during the period from 1925 to 1941, ranged in age from 24 to 44 years. The records show that 5 of the women had a Mantoux reaction of 4 plus. The results of examination of the 7 patients were as follows:

E. A.: The left eye revealed a small nodule on the iris, a posterior synechia and ciliary congestion, with scarring of the cornea. Vision was 20/20 in the right eye and 10/20 in the left eye.

I. S.: The right eye was red and painful and presented ciliary congestion with keratitic precipitates. Vision was 10/100 in the right eye and 20/25 in the left eye.

R. E. C.: The left eye presented a posterior synechia, congestion of the conjunctival vessels and a misty cornea. Vision was 20/20 in the right eye and was limited to light perception in the left eye.

G. A. Y.: Both eyes revealed opacities of the vitreous, deep corneal opacities and ciliary congestion. Vision was 10/100 in the right eye and 3/100 in the left eye.

G. M.: The right eye had been inflamed for three weeks prior to consultation. The episcleral tissues appeared red.

C. T.: The right eye presented tuberculous episcleritis. A nodule was discovered in the sclera above the pupil, at 12 o'clock. Vision was 6/100 in the right eye and 20/40 in the left eye.

C. S.: The left eye revealed evidence of cyclitis. The fundus was normal. Vision was 20/25 in the left eye.

R. E. C., who was unable to come to the city to continue with tuberculin therapy, eventually lost the sight of the left eye. C. T. and C. S. did not return for treatments. I. S. received seven series of treatments with old tuberculin in six years. In 1934 vision with glasses was 20/65 in the right eye and 20/20 in the left eye. The right eye was quiescent. There was no pain. The general condition was much improved. G. A. Y. received four series of injections of old tuberculin once a year for six years. In 1938 vision was improved to 20/50 in the right eye and to 20/65 in the left eye. Both eyes were quiescent, and there was no discomfort. She gained 15 pounds (6.8 Kg.) in weight. To date, G. M. has received one series of tuberculin injections and is still under treatment, with complete subsidence of symptoms. Vision has improved to 20/25 in the right eye and 20/25 in the left eye.

The foregoing examples indicate that whenever tuberculin therapy was instituted and administered systematically for a sufficiently long period, the response was in general satisfactory. The result of the Mantoux test not only served to confirm the diagnosis but afforded an indication of the size of the initial dose of tuberculin to be employed.

Many patients cannot carry out a prolonged series of treatments. Distance to the physician's office prevented R. E. C. from continuing her treatment. More and more people demand quick relief and will not consent to a two year program. Tuberculin should never be administered to a patient by even an internist unless he has special training in its use and has patience and perseverance. If the patient or the physician demands quick results, neither should consent to tuberculin therapy. Hurry means failure. Many physicians are afraid to administer tuberculin because, in their rush, they have given overdoses, with resulting reactions and disaster.

TREATMENT

It would be ideal if all patients with chronic uveitis of tuberculous origin could be admitted immediately to a sanatorium, but this is impos-

sible, for many reasons. In the sanatorium for tuberculous patients it is impossible for the patient to receive the necessary careful observation of his ocular lesion if he is under the care of the internist alone. The sanatoriums are already overcrowded and cannot possibly accommodate patients with ocular lesions. Economically, it does not seem necessary to hospitalize all patients with subacute or chronic uveitis. The purpose of the sanatorium is to offer special treatment for the patient with severe pulmonary disease and, secondarily, to isolate the patient. If the primary treatment in the hospital is rest in bed and a high vitamin and high caloric diet, the same results may be obtained by carefully supervised home treatment.

Diet.—In the accompanying table a program for a high caloric diet is presented.

Radium.—Many authors have had excellent results from the use of roentgen rays and radium in the treatment of ocular tuberculosis. For many lesions of the anterior segment of the eye, especially the cornea, treatment with radium is often satisfactory.

In the treatment of inflammatory lesions of the eye, comparable results may be obtained with small doses of radium. However, it is more difficult to obtain a uniform distribution with radium than with roentgen rays.

For lesions involving the cornea, the beta rays of radium may be used. If possible, the portion of the cornea not involved should be protected by a properly constructed lead shield, and the radium elements used in 0.5 mm. point steel needles. The dose is 100 to 150 milligram minutes, and three to four treatments are given at weekly intervals.

For the more deep-seated lesions, the gamma rays are utilized. The radium element may be used in 0.5 mm. point needles, held in place by a wax mold. A single dose of 25 to 50 milligram hours at a distance of 2.5 cm. may be sufficient for the acute inflammatory conditions. Lesions of a chronic nature require three or four weekly treatments.

Roentgen Rays.—In treating any inflammatory condition of the eye it is essential to remember that, although the eye shows a relative tolerance for roentgen rays, damage may be done, especially to the conjunctiva and the more sensitive lens, unless care is taken. Fortunately, however, the dose of roentgen rays most efficient for the treatment of any inflammatory condition of the eye is well below the limits of tolerance of the conjunctiva and lens. Under such conditions there should be no danger of producing cataract in the adult.

In children the danger is greater because, as has been shown experimentally, the rapid growth of the lens during early life makes the structure much more sensitive and cataracts may be induced even with moderate doses.

In general, roentgen ray therapy for tuberculosis of the eye is moderately effective and is usually limited to rather small and repeated doses. By a small dose is meant from 10 to 30 or 40 per cent of the erythema, or tolerance, dose for the skin of a young person. In terms of the international quantitative unit of roentgen radiation, this would mean from 40 to 160 r (measured in air).

The treatment is given directly over the eye, with the following factors: 100 to 120 kilovolts, 5 milliamperes, a 1 mm. aluminum filter, a distance of 30 cm. and 3 by 4 cm. or 6 by 8 cm. fields. For an adult, the dose depending on the precise character of the lesion, from 75 to 100 r is given once a week over each eye for four weeks. This series may be repeated, if necessary, in two months.

For chronic inflammatory lesions of the eye, the dose should be larger than for acute conditions, but it should never be so large as to endanger the structures of the most sensitive ocular parts, namely, the conjunctiva and the crystalline lens.

Gold Sodium Thiosulfate.—Gold salts have been used as nonspecific treatment for ocular tuberculosis. The patient may become sensitive to the drug and present symptoms of diarrhea,

Average Values Obtained in Daily Food Analyses for Several Weeks

Daily Average for Seven Day Periods	No. of Calories	Carbohydrates, Gm.	Protein, Gm.	Fat, Gm.	Calcium, Gm.	Phosphorus, Gm.	Iron, Gm.	Vitamins, International Units			
								A	B_1	C	B_2
	2,646	256	86	132	1.4368	1.72	0.01238	6,539	423	1,593	735
	2,617	263	82	135	1.3700	1.77	0.01331	6,540	421	1,312	681
	2,867	303	90	148	1.3550	1.72	0.01407	9,506	540	1,614	628
	3,005	324	89.5	150	1.3912	1.71	0.01501	5,707	424	1,689	692
	3,033	341	84.5	158	1.3789	1.60	0.01556	6,605	437	1,506	648
	3,041	356	90	168	1.3900	1.71	0.01458	8,419	401	1,718	782
Daily average for week of November 16-22	2,965	303	92	156	1.6024	1.87	0.01986	8,735	464	1,678	739
Average person's requirement			70	...	0.68	1.3	0.012	5,000	300	600	600

cutaneous rash and edema. Gold salts have fallen into disrepute with practitioners because of manifestations of intoxication and intolerance which occurred in consequence of incorrect treatment.

Gold sodium thiosulfate is administered twice a week for at least fifty or sixty injections. The dose is usually 25 mg. Some physicians start with an initial dose of 10 mg., each dose being increased by 5 mg., to a maximum of 50 mg.

Typhoid H Antigen.—Typhoid H antigen was advocated by Brown [11] for the treatment of intraocular inflammation in cases in which nonspecific immunization is an accepted therapeutic measure. A dose of 0.06 cc. of a solution of typhoid H antigen is administered intradermally. If there is no local reaction in thirty minutes, the patient is not sensitive to the antigen. Then 5,000,000 to 10,000,000 units of typhoid H antigen is given intravenously. In twenty-four hours another 5,000,000 units is given intravenously. Twenty-four hours after the last injection the paracentesis is performed.

MANTOUX DIAGNOSTIC TESTS

Purified Protein Derivative of Tuberculin.—Seibert's purified protein derivative is recommended for the intradermal test of tuberculosis because it is uniform in strength. This preparation is expensive. It deteriorates quickly and cannot be used for more than three days after preparation.

The test is carried out with doses of two strengths. Persons who do not react to an injection of the first test strength have a second injection forty-eight hours later with a dose of the second test strength.

First Test Strength: An intradermal injection of 0.1 cc. from a vial containing 0.0002 mg. of purified protein derivative is made on the forearm. Readings are made in forty-eight hours.

Second Test Strength: If no reaction occurs in the first test, an intradermal injection is made on the forearm of 0.1 cc. from the vial containing 0.05 mg. of purified protein derivative, a dose which is two hundred and fifty times that in the first test.

If a quantitative determination is desired, according to Adler, an initial dose of 0.000001 mg. per cubic centimeter of purified protein derivative of the first test strength may be given intradermally. The dose is increased tenfold for each succeeding intradermal injection until a positive reaction is obtained. This is the quantitative test of Aronson.

Old Tuberculin.—The old tuberculin of Koch is used intradermally for the diagnosis of tuberculosis. This is the Mantoux test. Old tuberculin will not deteriorate as rapidly as purified protein derivative. It is much less expensive.

Three dilutions of old tuberculin are made, as follows: 1:100,000; 1:10,000, and 1:100. An intracutaneous injection of 0.1 cc. of solution 1:100,000 of old tuberculin (0.001 mg.) is given. If no local reaction follows, 0.1 cc. (0.01 mg.) of solution 1:10,000 of old tuberculin is administered intracutaneously. Later, 0.1 cc. (0.01 mg.) of solution 1:100 of old tuberculin is injected intracutaneously. If no local reaction is obtained with the usual test of three dilutions, the strength may be increased, 1, 5 or, finally, 10 mg. of old tuberculin being injected intracutaneously.

The cutaneous reactions have been classified as follows:

Grade	Area of Redness and Edema, Diameter in Mm.
+	5—10
++	10—20
+++	More than 20
++++	Pronounced; some necrosis

Haessler [12] stated:

> If one does not believe in the efficiency of specific therapy with tuberculin, there is hardly a logical reason for differentiating tuberculosis from the many other etiological factors which cause inflammation in the eye.

PREPARATION AND ADMINISTRATION OF OLD TUBERCULIN

In preparing the solutions of old tuberculin, phenol, in 0.25 per cent concentration in isotonic solution of sodium chloride, is used as a diluent. The solutions are stable for about two weeks if kept in an ice box.

To make a series of dilutions, 1:10, 1:100, 1:1,000, and so on, the bottles are numbered to correspond to the number of zeros in the denominator: for example, solution 1/1, 2/1, 3/1, and so on.

The data for the series of dilutions may be summarized as follows:

Old Tuberculin, Cc. of Solution No.	Diluent, Cc.	Dilution	Solution No.	Amount of Old Tuberculin, Mg. per Cc. of Solution
0.1 cc.	0.9	1:10	1/1	100.0
1.0 cc. of 1/1	9.0	1:100	2/1	10.0
1.0 cc. of 2/1	9.0	1:1,000	3/1	1.0
1.0 cc. of 3/1	9.0	1:10,000	4/1	0.1
1.0 cc. of 4/1	9.0	1:100,000	5/1	0.01
1.0 cc. of 5/1	9.0	1:1,000,000	6/1	0.001

11. Brown, A. L.: Use of Typhoid H Antigen Before Intraocular Operations, Arch. Ophth. **19**:181 (Feb.) 1938.

12. Haessler, F. H.: Minnesota Med. **26**:161, 1943.

The following scheme, computed by Pope, and employed at the Trudeau Sanatorium, is based on a logarithmic scale and is arranged so that when the dose is increased from 0.1 to 1 cc. of any solution, two to twelve doses may be employed, while the rate of increase of the dose in each case is always constant.

Doses (Logarithmic Scale)

1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	1	1	1	1	1	1	1	1
	3.2	2.2	1.8	1.6	1.5	1.4	1.3	1.3	1.3	1.2	1.2
	10	4.7	3.2	2.5	2.2	2.0	1.8	1.7	1.6	1.5	1.5
		10	5.6	4.0	3.2	2.7	2.4	2.2	2.0	1.8	1.8
			10	6.3	4.7	3.7	3.2	2.8	2.5	2.3	2.2
				10	6.8	5.2	4.2	3.6	3.2	2.9	2.6
					10	7.2	5.6	4.7	4.0	3.5	3.2
						10	7.5	6.0	5.0	4.3	3.8
							10	7.7	6.3	5.3	4.7
								10	8.0	6.6	5.6
									10	8.0	6.8
										10	8.3
											10

Several rates of increase for the use of tuberculin were employed. After the maximum dose with solution 6/1 was given, the series of injections were repeated with solution 5/1. The treatment is continued through the series of dilutions until a dose of 1 mg. is reached. Ordinarily, the dose is not carried above 1 mg. of old tuberculin. To avoid all local and general reactions, the patient takes and records his temperature three times a day, after each injection of old tuberculin, for thirty-six hours. If signs or symptoms of reaction occur, one or two treatments are omitted and the dose is reduced when the injections are started again.

In the treatment of patients with ocular tuberculosis the aim is to cure the entire process in the organism by general treatment and not by treatment only of the local disease. Its basis is a knowledge of the entire disease picture, of the principal clinical forms of ocular tuberculosis, of the primary, generally intrathoracic origin of the infection, and of generalized tuberculosis. . . . The point of attack of any useful therapy is the organism as a whole, especially in the initial phase of the disease, and the attempt should be made to change the key, to swing or transpose the constitutional tuberculosis into a more benign form of the disease. A second favorable phase is that in which there is a favorable response to aggressive general kind of local treatment, such as specific therapy, treatment with x-rays and so forth. Two main clinical groups of ocular tuberculosis stand in therapeutic opposition: malignant, exudative forms with the subjects toxin-sensitive, calling for conservative, general and local treatment, on the one hand, and on the other, benign, productive or fibrous forms, with the subjects less toxin-sensitive, indicating a more aggressive therapy.[13]

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13. Werdenberg: Useful and Harmful Therapeutics in Tuberculosis, Arch. Ophth. **13**:303 (Feb.) 1935.

COMPARISON OF THE OBLIQUE EXTRAOCULAR MUSCLES

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The oblique muscles in many respects are the most interesting of all the extraocular muscles. They have been regarded by most authors as a pair, and emphasis is usually placed on their similarity to each other and to the rectus muscles. When the superior and the inferior oblique muscles are considered separately, however, and are compared one with the other, many significant contrasts are revealed. In presenting such a comparison, therefore, this paper expresses only in a rather unique form that of which most ophthalmologists are already cognizant.

ANATOMIC RELATIONS

Embryologically, the orbital muscles are said to be derived from the head, or cephalic, mesoblastic somites. The inferior oblique muscle, like all the muscles supplied by the third nerve, is derived from the first somite, while the superior oblique muscle originates from the second somite.

The superior oblique muscle arises in the posterior part of the orbit from the mesial aspect of the annulus of Zinn and is contiguous with the origin of the internal rectus muscle. The belly of the muscle extends anteriorly, close to the nasal wall, to the upper, inner and posterior surface of the orbital rim, where it is reflected around the trochlea. This "pully" is a ligamentous, looplike attachment in the fovea trochlearis of the orbital surface of the frontal bone. From the trochlea to its insertion on the globe, the superior oblique muscle is entirely tendinous, about 20 mm. in length, according to Whitnall.[1] It is the longest muscle and has the longest tendon of all the extraocular muscles.

The inferior oblique muscle, by way of contrast, is the shortest of the extraocular muscles and is composed purely of striated muscle fibers, having practically no tendon at all. The only muscle arising in the anterior part of the orbit, it has for its origin a small fossa in the maxillary bone just inside the lower inner quadrant of the orbital rim. It proceeds posteriorly and laterally and is inferior to the globe.

The oblique muscles are ensheathed, like the rectus muscles, between the internal capsule of Tenon's fascia, on their ocular surfaces, and the external capsule, on their orbital surfaces. According to Motais (cited by Maddox[2]), the internal superior check ligament of the superior rectus muscle applies itself to the tendon sheath of the superior oblique muscle. The check ligament of the inferior oblique muscle, on the other hand, leaves the muscle sheath 8 to 10 mm. from the origin of the muscle and crosses obliquely forward and outward to the outer angle of the orbit. Being purely a fibrous aponeurosis, it not only acts as a check to the relaxation or extension of the muscle but modifies the effect of the muscle pull during contraction, as will be seen later. By way of contrast, then, the superior oblique muscle may be said to have no real check ligament of its own, while the inferior oblique muscle has the longest and strongest in the orbit.

Howe,[3] in a large series of dissections and plottings, presented a comparison of the insertions of the two muscles. The insertion of the superior oblique muscle is variable; its tendon spreads out across the vertical meridian in a backwardly directed convex line. According to Fuchs,[4] in emmetropic eyes the average insertion is 10.7 mm. in breadth. The anterior end is about 14.6 mm. from the optic nerve and lies in the same meridian as the lateral border of the superior rectus muscle, while the posterior end is about 7.5 mm. from the nerve. Again, by way of contrast, the insertion of the inferior oblique muscle is rather constant in its location (so much so that it may be used in operations for retinal detachment as one of the few definite landmarks on the posterior surface of the globe). Having no real tendon, the muscle fibers are inserted directly into the sclera on the horizontal meridian of the globe, making a right angle with the external rectus muscle. The line of insertion is about 10 mm. long, and in normal eyes its center is 2.2 mm. from the spot cor-

1. Whitnall, E. S.: The Anatomy of the Human Orbit, ed. 2, London, Humphrey Milford, 1932.

2. Maddox, E. E.: Tests and Studies of the Ocular Muscles, Philadelphia, Keystone Publishing Co., 1907.

3. Howe, L.: The Muscles of the Eye, New York, G. P. Putnam's Sons, 1908, vol. 1.

4. Fuchs, E.: Text-Book of Ophthalmology, translated by A. Duane, ed. 7, Philadelphia, J. B. Lippincott Company, 1923.

responding to the fovea and 5.2 mm. from the optic nerve. An obvious contrast, which is not generally realized, is the fact that the insertion of the superior oblique muscle is anterior to the superior pair of vortex veins, while the inferior oblique muscle is inserted posterior (and lateral) to the inferior pair of vortex veins.

Little of the superior oblique muscle is taken up in the so-called arc of contact, while nearly half the length of the inferior oblique muscle is wrapped around the globe. Both oblique muscles pass beneath the corresponding vertically acting rectus muscles, and this undoubtedly acts to their mechanical disadvantage in certain ocular movements, as noted later.

With regard to the nerve supply, a difference is again seen between the oblique muscles. The superior oblique muscle is innervated by the trochlear nerve, which arises from the nucleus of the fourth nerve on the contralateral side of the medulla. The inferior oblique muscle is supplied by a branch of the oculomotor nerve, which originates in a collection of centers composing the nucleus of the third nerve. Maddox,[2] in 1907, stated that it is probable that the nucleus of the fibers to the inferior oblique muscle lies on the opposite side of the median plane, so that a decussation of the fibers of the third nerve, analogous to that of the trochlear nerve, is necessary, but this has not been substantiated. Some authors have indicated that the fibers to the inferior oblique muscle arise from the ipsilateral nucleus, but Bing[5] and Whitnall[1] expressed agreement that there is probably some degree of bilateral innervation.

ACTION OF THE OBLIQUE MUSCLES

The planes of action of the two oblique muscles were said by Maddox[2] to be identical, each making an angle of 51 degrees with the median plane. From the corrected figures of Volkmann,[6] however, the tendon of the superior oblique muscle makes an angle with the median plane of 55°21′, while the inferior oblique muscle makes an angle of only 50°57′. This means that the inferior oblique muscle has a greater vertical purchase on the globe than does the superior oblique muscle; i. e., its plane of action is closer to the anteroposterior diameter. In fact, the inferior oblique is actually pulled more closely toward parallelism with the median plane by its check ligament, which pulls the muscle belly laterally, as previously noted. Thus the inferior oblique muscle contributes more of its energy to elevation than the superior oblique contributes to depression, the ratio being 60:57, or 42 per cent to 37 per cent, as indicated by Verrijp.[7]

Maddox[2] pointed out that the speed with which a muscle's point of insertion moves is proportional to its length. The fact that the inferior oblique muscle is longer than the "effective" portion of the superior oblique muscle and that its insertion is farther from the center of rotation means that for the same amount of contraction the inferior oblique muscle will produce a greater vertical displacement of the eye than will the superior oblique muscle.

Duane[8] implied that when the eye is in the primary position the vertical pull of each of the oblique muscles is about equal to that of the opposing vertically acting rectus muscle. However, Weiland,[9] Maddox[2] and Tschermak[10] agreed that in such a comparison the oblique muscles exhibit much less vertical pull than their antagonists.

As is quite evident, the vertical pull of the oblique muscles increases as the eye is internally rotated and the anteroposterior diameter of the globe more nearly approaches the planes of action of the respective muscles, being maximum for the inferior oblique muscle at 50°57′ and for the superior oblique muscle at 55°21′ of internal rotation. The elevating or depressing action, as the case may be, decreases as the eye is externally rotated.

In like manner, because the insertions of the oblique muscles are lateral to the anteroposterior diameter of the globe, each produces a torsional effect. On contraction the superior oblique muscle causes intorsion; the inferior oblique muscle, being wrapped around the lower portion of the eye, causes extorsion. The tortional effects of the two oblique muscles although opposite in direction, are about equal in amount. The maximum torsional effect of the oblique muscles, in contradistinction to their maximum vertical pull, as just mentioned, is obtained when the eye is externally rotated and the anteroposterior diameter of the eye approaches a posi-

5. Bing, R.: Compendium of Regional Diagnosis in Lesions of the Brain and Spinal Cord, ed. 11, St. Louis, C. V. Mosby Company, 1940.

6. Volkmann, A. W.: Zur Mechanik der Augenmuskeln, Ber. u. d. Verhandl. d. k. Sächs. Gesellsch. d. Wissensch. **21**:28, 1869.

7. Verrijp, C. D.: Movements of the Eyes, in Berens, C.: Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, chap. 50.

8. Duane, A.: A New Classification of the Motor Anomalies of the Eye, New York, J. H. Vail & Co., 1897.

9. Weiland, C.: The Law of Listing and Some Disputed Points About Its Proof, Arch. Ophth. **28**:191, 1899.

10. Tschermak, A.: Augenbewegungen, in Bethe, A.; von Bergmann, G.; Embden, G., and Ellenger, A.: Handbuch der normalen und pathologischen Physiologie, Berlin, Julius Springer, 1931, vol. 12, pt. 2.

tion of a right angle to the plane of action of the muscles. The torsional action is diminished with internal rotation and is nil when the line of fixation coincides with the respective muscle planes.

The effect of the oblique muscles around the vertical axis of rotation remains to be considered. The oblique muscles tend to rotate the eye externally, and, just as for torsion, this tendency increases as the eye continues to rotate outward and diminishes with internal rotation. Certainly, this is true in the case of the superior oblique muscle, the insertion of which on the upper, outer and posterior surface of the globe necessitates the tendon's passing posterior to the vertical axis. On contraction of the superior oblique muscle, its origin (and the posterior pole of the eye) is drawn toward the midline; i. e., the eye is rotated outward.

The same horizontal action in the form of external rotation is ascribed to the inferior oblique muscle. This teaching is in accordance with accepted clinical observations and has been endorsed by Duane,[11] Peter,[12] Maddox,[2] Savage,[13] Stevens [14] and others. It is based on the assumption that the inferior oblique muscle passes posterior to the vertical axis of rotation, as does the superior oblique muscle. Reference to Volkmann's [6] anatomic measurements, however, shows that the plane of the inferior oblique muscle actually passes anterior to the vertical axis. If this is true, in contraction the muscle must pull its insertion (and posterior pole) away from the midline, or internally rotate the eye. Furthermore, as internal rotation continues, the insertion and line of pull of the muscle both become increasingly more anterior to the center of rotation, and inward rotation is accentuated. This is quite the opposite of the superior oblique muscle, the lateral rotational effect of which, as already noted, diminishes as the eye is turned inward. During external rotation, on the other hand, the plane of the inferior oblique muscle will reach a point where it passes through the vertical axis, at which time the horizonal pull will be nil; then, as the eye continues to turn outward, the pull of the muscle will pass posterior to the vertical axis, and beyond this point, as with the superior oblique muscle, it will increase in its external rotating component.

It seems strange that after almost a century the true action of the inferior oblique muscle should still be in apparent doubt. The orthodox belief that the muscle acts as an external rotator is supported by many eminent clinical observers, while the position of the other school, which maintains the action to be that of an internal rotator, is based on accurate anatomic dissection and sound mathematical computation. When one recalls that in ordinary use emmetropic persons do not move their eyes more than 12 degrees to the right or left before movements of the head become a factor, as Fischer [15] has shown, the true action of the inferior oblique muscle from the position of "eyes front" becomes of increased importance.

PARALYSIS

Paralysis is probably the most common pathologic condition affecting the individual extraocular muscles; and here, again, a contrast is found between the two oblique muscles. The superior oblique muscle is the second most frequently paralyzed of all the extraocular muscles (being exceeded only by the external rectus muscle), while the inferior oblique muscle certainly presents the lowest incidence of isolated oculomotor paralyses. The inferior oblique mucle derives its innervation from the same branch of the third nerve as do the ciliary muscle and the sphincter muscle of the iris; hence, in cases of postorbital lesions paralysis of the inferior oblique muscle is accompanied by internal ophthalmoplegia.

Paralyses of both the superior and the inferior oblique muscle, as Peter [12] indicated, present the usual symptoms, among which the most diagnostic are ocular deviation, limitation of movement, false projection and diplopia. Although "the eye turns away from the field of action of the paralyzed muscle," Peter [12] emphasized the fact that the deviation may not be very noticeable, since the oblique muscles act vertically and there is more than one elevator and one depressor for each eye. However, paralysis of the inferior oblique muscle, for anatomic reasons already noted, should produce a greater ocular deviation than a corresponding paralysis of the superior oblique muscle. Limitation of movement and vertical diplopia will be greatest when the eye is turned so that the anteroposterior diameter of the globe is in the plane of action of the muscle, i. e., where the muscle has its maximum vertical component. With paralysis of the superior oblique muscle, as has been noted, this maximum is reached when an attempt

11. Duane, A.: The Monocular Movements, Arch. Ophth. **8**:530 (Oct.) 1932.

12. Peter, L. C.: The Extra-Ocular Muscles, ed. 3, Philadelphia, Lea & Febiger, 1941.

13. Savage, G. C.: Ophthalmic Myology, Nashville, Tenn., privately printed, 1902.

14. Stevens, G. T.: The Motor Apparatus of the Eye, Philadelphia, F. A. Davis & Co., 1906.

15. Fischer, F. P.: Ueber die Verwendung von Kopfbewegungen beim Umhersehen, Arch. f. Ophth. **113**:394, 1929.

is made to turn the eye down and in; with paralysis of the inferior oblique muscle, when an attempt is made to turn the eye up and in.

Mauther (cited by Maddox [2]) showed that the separation of the images of the two eyes is greater with paralysis of the inferior oblique than with paralysis of the superior oblique muscle, since the former muscle, as previously mentioned, has a greater "arc of contact," is inserted farther from the center and pulls nearer the midline, a position which gives it a greater vertical purchase on the globe. With paralysis of the superior oblique muscle, which acts as an intorter, the false image leans to the normal (opposite) side; with paralysis of the inferior oblique muscle, which acts as an extorter, its false image leans to the affected (same) side. Paralysis of both oblique muscles produces a slight homonymous lateral separation of the images (except in cases of preexisting exophoria), a phenomenon which confirms the contention of Maddox [2] and verifies the results of Volkmann's [6] studies, namely, that the oblique muscles do not rotate about a common axis.

SUMMARY

The oblique extraocular muscles present many interesting contrasts. The superior oblique muscle arises at the optic foramen and is the longest muscle in the orbit; the inferior oblique muscle arises at the orbital foramen and is the shortest. The superior oblique muscle has the longest tendon of all the extraocular muscles but no check ligament, while the inferior oblique muscle has no tendon but has the longest check ligament. The superior oblique muscle has the most variable of insertions, the line being usually on the vertical meridian, anterior to the vortex veins; the inferior oblique muscle has the most constant of insertions, being located on the horizontal meridian and posterior to the vortex veins. The arc of contact for the superior oblique muscle is shorter than that for any of the other muscles; that for the inferior oblique muscle is the longest of all. The superior oblique muscle has a contralateral innervation, and the inferior oblique muscle, an ipsilateral or a biliteral representation. The superior oblique muscle acts as a depressor, and the inferior oblique as an elevator; their respective actions increase as the eye turns inward and decrease as the eye turns outward. The former acts as an intorter, and the latter, as an extorter; both torsional actions increase as the eye is turned outward and decrease as it is turned inward. Both muscles are reputed to act as external rotators, which action increases as the eye turns outward and decreases as the eye turns inward. In the case of the inferior oblique muscle, however, there may still be a question whether it acts as an internal or as an external rotator. The superior oblique muscle is the second most frequently paralyzed muscle; the inferior oblique muscle is the least frequently involved, and then is often accompanied by internal ophthalmoplegia. With paralysis of the superior oblique muscle limitation of movement and vertical diplopia are greatest when the eye is turned down and in, and with paralysis of the inferior oblique muscle, when the eye is turned up and in. Vertical diplopia is greater with paralysis of the inferior oblique muscle than with paralysis of the superior oblique muscle. The false image representing the superior oblique muscle leans to the normal (opposite) side, and that of the inferior oblique muscle leans to the affected (same) side.

1930 Chestnut Street.

PROSTHESES FOR THE EYE AND ORBIT

ADOLPH M. BROWN, M.D.
CHICAGO

After destruction of the eye, a glass eye is sufficient prosthesis unless the eyelids are also missing. Patients who require only a glass eye do not present themselves at the prosthetic laboratory. Most commonly a prosthesis is required after surgical exenteration of the entire orbital contents. The patient is confronted with a number of choices: (*a*) to flaunt the defect, walking about with it visible and making no effort to conceal it; (*b*) to hide the defect with a bandage, and (*c*) to substitute a prosthesis for the lost organ or portion of an organ.

A prosthesis for the orbit should not be made until the skin of the area is adequately healed, unless provision is made on the under surface of the prosthesis for protection of any raw or granulating areas. Figure 1 shows a 20 year old woman who had had exenteration of the entire orbital contents for glioma six years previously. The orbital wound opened at the region of the inner canthus into the sphenoid sinus. The sinus had been draining through this opening for years. The prosthesis illustrated was designed so that there was no contact of rubber and skin near the open area. When the patient wore her prosthesis, there was less crusting and she apparently enjoyed more comfort.

The skin of the upper part of the cheek, around the outer canthus of the eye, is supported on unusually delicate beds of fat. For this reason, a prosthesis planned and processed in the ordinary way makes the eyes appear asymmetric. After several disappointments in cases in which additional corrections were required, I realized that the impressions had been made while the patient was supine. The prosthesis had been designed on these impressions, and when they had been fitted the patient was again supine. When the patient was upright, the prosthetic eye seemed lower than the normal eye, although it had been placed correctly by calibration. The weight of even a light prosthesis was sufficient to cause the orbital edge of the skin to sag ⅛ to ¼ inch (0.3 to 0.7 cm.) below its normal position.

From the Eye and Ear Infirmary, the University of Illinois.

Two overcorrections are necessary, therefore, in making a prosthetic eye and lids. In the first place, the entire orbit should be sculptured slightly higher on the face than its opposite. In the second place, the conjunctiva should be slightly more visible in the prosthesis than in the normal eye. In other words, the artificial eye must be slightly more opened than the normal eye.

In making a prosthetic eye and lid an impression is made of the normal eye first. This impression may be made as usual with plaster, with the eye closed, or it may be made with a gelatinous compound, with the eye open. While the positive mold is being cast, the patient is sent to have the normal eye matched for a glass eye. If possible, it is advisable for the patient to obtain two glass eyes. Glass eyes are almost invariably too large in circumference, because they are made to be tucked into living eyelids. When the prosthetist receives the glass eye, he mounts it in molding clay in its correct anatomic position and determines how much trimming of the edge of the glass eye will be necessary. The border of excessive artificial conjunctiva is marked with a wax pencil, and the excess glass is ground away. The glass of an artificial eye is carefully tempered, but it is still fragile, and breakage during the grinding is not uncommon. Once the edge is trimmed, the artificial eye is ready to be mounted accurately in the molding clay. By careful mensuration of the model and the patient, the site for the eye is determined, and the sculpture proceeds with the glass eye in place. The site for the eye is corrected slightly, so as to place it a little above its true position on the face. The upper lid of the sculptured model is made slightly thicker than the lid of the opposite side, to provide enough thickness for a trench to be cut. This fissure will contain the "roots" of the artificial eyelashes to be added later. When the eye and orbit are accurately sculptured, the model is ready for the casting of the second half of the mold. It is not necessary to draw in the fine pores and epithelial tracery that other prostheses require. After the top half of the mold has set, the parts are separated; the modeling clay is washed out, and the glass eye is

retrieved. Later, when the mold is ready to cast in rubber, the glass eye will be lightly glued in place on the upper half, so that after the rubber is poured it will be accurately embedded in the rubber lids.

In making a prosthesis for exenteration of the orbit only, a negative impression is made with no. 1 molding plaster, and from this a positive impression is cast in dental stone or hydrocal. The eye is then sculptured on the positive cast. To sculpture the eye, the prosthetist must rely on his patient to sit for him, so that he may make the prosthetic eye a mirror image of the remaining one. This is sometimes difficult for both the patient and the doctor. In such cases it is advisable to make an impression of the remaining eye while it is open for reference while sculpturing the prosthesis.

Negocoll was formerly used for making impressions with the eye open. In order to make an impression of this type it is necessary, of course, to anesthetize the conjunctiva. When Negocoll was used, it was necessary to stir the hot mixture and cool it slowly until the proper temperature was reached so that a satisfactory negative impression could be made and, at the same time, the conjunctiva and eyelid would not be injured by the heat. Other gelatin compounds also required boiling and stirring and then had to be cooled slowly to about 106 F. (40 C.), at which temperature they made effective impressions and caused no harm to the eye. But these compounds had to be used quickly and delicately within the critical period, and the margin for error was rather narrow.

Modern compounds for negative impressions are greatly improved. They are supplied in the form of molding powders and require mixing with distilled water only. They are then spatulated to a smooth, air-free mixture, and the casting of the impression is done in the usual manner. Gelatinous impression compounds are placed on the eye at a relatively low temperature. There is no discomfort to the patient, no irritation and no subsequent chemosis, and particles rarely remain in the eye after the cast has been removed. Gelatinous impression compounds are easy to handle. They require no special equipment and produce accurate, detailed impressions of eyes and even of overhanging wrinkles containing undercuts. In handling them, flexible rubber bowls may even be dispensed with, if necessary, and paper cups substituted. Ordinarily, however, a rubber bowl for mixing is required, together with spatula and a graduate. When mixed with distilled water, these compounds react chemically to form a highly elastic gelatinous mass. After a few attempts the operator can best determine the amount of powder and distilled water suitable for his particular needs.

The following method has proved satisfactory in my work, but it can be variously modified to meet individual requirements. The eye is anesthetized before the impression is made. Ordinarily 2 drops of anesthetic is placed in the eye

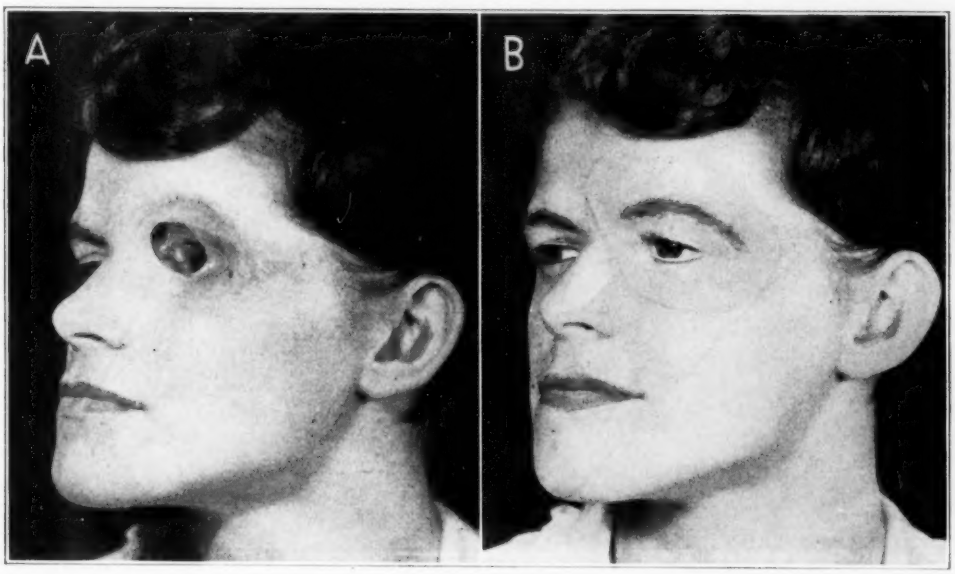


Fig. 1.—Face after surgical exenteration of the entire orbital contents for retinoblastoma: (*A*) without and (*B*) with a prosthesis. The prosthesis had to be designed as a relatively thin sculptured patch to avoid contact with the exposed sinuses.

about five minutes before the powder is mixed. A few minutes should be allowed to elapse between instillations. Another drop may be instilled when the operator begins the spatulation. A minute or two later a fourth drop of anesthetic may be instilled, with a drop of epinephrine hydrochloride solution if desired. Pour the required amount of distilled water into a rubber bowl. Tap the container of molding compound on the table to settle the contents; then add 1 Gm. of powder for every 5.5 cc. of water. Roughly, bulk for bulk of powder and water can be mixed together. The graduate should be thoroughly dry before the powder is measured. Mix the water and powder, and spatulate the mixture till it is smooth. The bowl may now be tapped on the table a few times to

Fig. 2.—Four year old boy two years after surgical removal of the right orbit: (*A*) without and (*B*) with prosthesis. Glasses disguise the edges of the restoration. A prosthesis furnished before a child reaches school age promotes confidence and goes far to stop the cruel taunts of schoolmates.

force trapped air to the surface. When the bubbles of air have been scooped off, the mixture is ready to be applied. It should be kept in contact with the surface to be molded for three or four minutes. While the impression is being made the patient should be reclining, and he should have been instructed to keep his eye fixed on a stationary point on the ceiling. Reassure the patient continuously during this procedure, because the process tends to make the patient extremely nervous. I find that the more reassurance I give the patient, the less muscular flicker results. Before removing the cast, be sure that the mold is firm and is not tacky. Do not hesitate to touch it with your finger after a few minutes to determine its firmness. When the consistency is satisfactory, the impression is removed in the usual manner and is ready for fixing.

The setting time of gelatinous molding powders may be hastened (1) by using warmer water, (2) by spatulating more vigorously and for a longer time and (3) by reducing the proportion of water used. It is sometimes necessary to achieve a longer setting period, so that alterations can be made in the negative impression while it is still moldable. The setting time can be lengthened (1) by using cold water or ice water, (2) by slower, more gentle spatulation and (3) by increasing the proportion of water used.

Fixatives for gelatinous molding compounds are generally supplied in the form of tablets that are dissolved in water to make a solution which hardens the molds and thus preserves the impression. The fixing solution may be painted or sprayed over the negative mold, or the mold may be immersed in the fixing solution. If the mold is small enough, it is always advisable to immerse it in the solution. To avoid distortion, cotton padding should be placed on the bottom of the containing vessel. It is necessary to avoid contamination of other solutions with the fixing solution; therefore, all solutions should be conspicuously marked. Generally, it is best to make a positive cast about an hour after fixing the mold. The negative should be separated from the positive impression about an hour after the stone becomes hard. As in all casting, it is advisable to use a type of dental stone or plaster with the least expansion and contraction. Also,

the compounds should be fine textured and hard surfaced. The technic for making a positive cast from a gelatinous negative mold is about the same as for making one from a plaster mold. The necessary amount of water is placed in a mixing bowl, and sufficient stone or plaster is added to absorb all of the water. The mixture is spatulated until it is smooth, and the bowl is tapped on the table or placed on a vibrator to eliminate bubbles. The top layer of plaster is then discarded, because it probably contains the undesired bubbles of air. The mixture is poured onto the negative mold from one side, so that it flows across the impression; this reduces the probability of enclosing pockets of air.

The hydrogen ion concentration of the gelatin compounds used for impressions of the eye should be within physiologic limits, and the mixture should be buffered. Control of the hydrogen ion concentration is effective in eliminating danger of injury to the eye and helps to lessen the patient's distress.

Ulcerated portions in the area to be covered by a prosthesis must be protected from contact with the prosthetic device, and it is sometimes essential that recently grafted skin be protected against contact with foreign material. This is especially necessary after ablation of carcinomatous tissue. Patients often apply for prostheses with the defective area still covered with friable, crusty, new skin grafts. Under such circumstances the positive cast must be altered by the addition of plaster to the area in which no contact is desired between the prosthesis and the skin. The positive cast and the needs of the patient should be carefully studied.

The operator should realize that his purpose is not simply to fashion a pretty organ that will be a neat and beautiful example of esthetic modeling. Rather, a prosthesis should be considered merely as a substitute, an inconspicuous replacement for a missing organ. The ambition of the prosthetist should be not to create a striking example of sculpture but to make the patient's countenance as a whole as unobtrusive as possible.

The ensemble of the positive cast bearing the sculpture is next covered with freshly mixed plaster to form a two piece mold containing the sculptured restoration. When the plaster has hardened, the parts of the mold are separated, the sculpture is removed and the clay is washed out. The mold is thoroughly dried and is then ready for the construction of a pouring channel.

The pouring channel is usually made through the posterior portion of the mold or die. I find it best to make a conical channel with a diameter of at least ¼ inch (0.6 cm.), to allow for easy pouring. Channels may be cut along the edge of the mold also, in such a way as to avoid altering the sculpture. It is a good rule to avoid channels which involve the anterior surface of the mold. If the mold is not thick enough or deep enough, it may be necessary to build an embankment of plaster around the pouring channels in such a way as to enlarge the cubical contents of the pouring channel. The flue must be large enough to contain enough rubber to keep the mold filled as the water is absorbed.

The amount of latex to prepare at one time varies with the number of prostheses one is about to cast. Because the zinc oxide that is added tends to hasten the coagulation time of the rubber, only a sufficient amount of the mixture to meet one's immediate needs should be prepared at a time. I usually prepare enough for several prostheses. I then divide the batch into

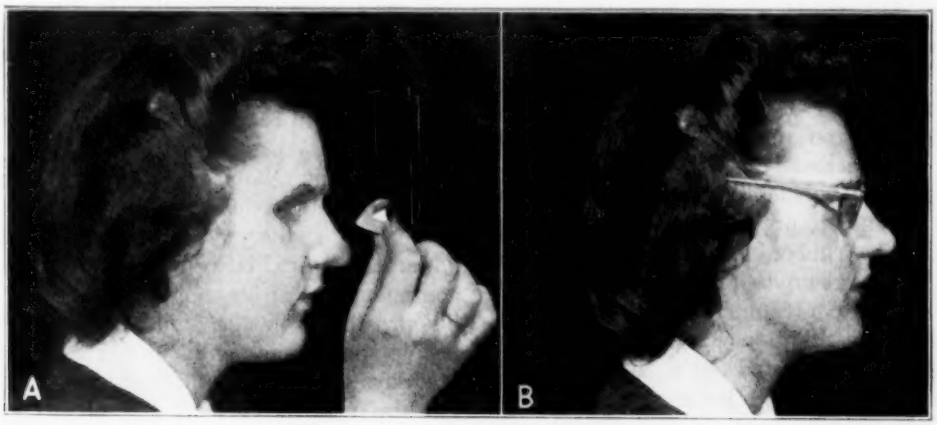


Fig. 3.—Side view of the patient after surgical removal of the orbit: (*A*) without prosthesis and (*B*) with prosthesis and glasses.

several small portions and color each for an individual prosthesis.

From the mixture prepared for each prosthesis, it is wise to save a sample in a specimen mold or as scrap and to keep a record of the formula used. The record should state the type of latex used (including the trade name), the amount and type of filler, such as bentonite, starch or whiting, used and the formula for the color.

Sample Record

Latex compound (trade name)	
Bentonite	1%
Zinc oxide	2%
D. C. red no. 7 [1] / Suntan no. 2770 [1]	10%

(2 drops per ounce [30 Gm.])

Such a record is of special value to the neophyte prosthetist, for as the record grows in size reference to it eliminates much disappointing trial and error in casting rubber.

Once the rubber is prepared, it should be poured without too much delay. A piece of adhesive tape across the top of the beaker captures the air bubbles on the surface of the mixture and tends to prevent them from entering the mold. The rubber should be poured in a thin trickle or stream to permit the air in the mold to escape. If one desires a hollow prosthesis that is light in weight, the contents of the mold may be poured out again after about half an hour. This will leave a thin shell of rubber, with the interior empty. If the wall of the prosthesis is found to be too thin, the shell may be refilled after several minutes to build a thicker wall. Experience and the needs of the individual patient will help the prosthetist decide whether to make the prosthesis hollow and delicate or solid and heavy.

After the prosthesis is removed from the mold, it is left resting on one half of the mold for a day or so to permit the rubber to cure by contact with air. The flashing is trimmed off with a burning pencil and manicure scissors or a granite-grinding wheel. The glass eye is removed from the rubber eyelids, and with the thin blade of an electric burning pencil a groove is cut along the lower edge of the upper lid. Artificial eyelashes are fitted into this groove. Such lashes are supplied commercially in brown and black. After they are in place, the lashes are shortened and thinned with manicure scissors. It is not necessary to supply lower eyelashes. The glass eye is reinserted under the artificial lids, and the prosthesis is ready to be worn. It is glued in place with an adhesive containing gum mastic. Glasses may be worn over the prosthesis, but they are not necessary to support it. However, the edge of the lens and the temple bar tend to disguise the edges of the prosthesis.

If the patient reacts as most of mine have, after receiving his prosthesis he first displays it proudly to his relatives and intimate friends who know of his predicament. He receives compliments for the artistry of the restoration, admiration for his courage and friendly encouragement. If his morale is good, he displays his prosthesis in the same manner as normal people show their dental bridge work. After a few days he begins to meet strangers again, and his aim now is to keep the prosthesis as inconspicuous as possible. Therefore, the objective in sculpturing restorations is not to create a beautifully modeled part which attracts attention and admiration but to fashion a restoration that will permit the patient to fall back gratefully into the inconspicuous place he desires.

540 North Michigan Avenue.

1. Manufactured by the Kohnstamm Color Co., Chicago.

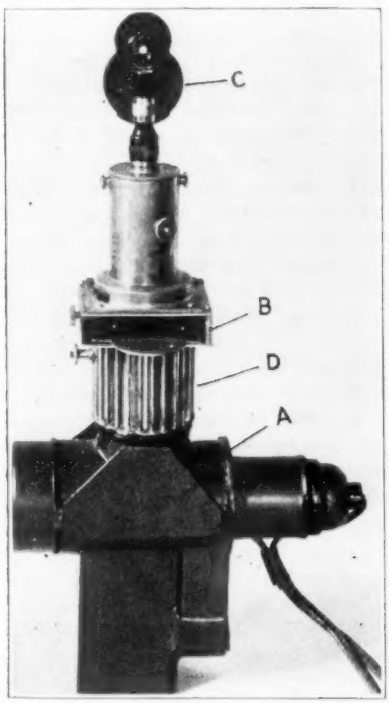
Clinical Notes

AN ABSOLUTE MONOCHROMATIC OPHTHALMOSCOPE

JACOB B. FELDMAN, M.D., PHILADELPHIA

For the past three years I have used an absolute monochromatic ophthalmoscope of my own design and have compared observations with those made with the ordinary electric type. A spectroscope insures the monochromatic quality of the colors used in my ophthalmoscope.

Several hundred careful fundal examinations were made on normal persons as well as on those with pathologic conditions. These studies were temporarily discontinued [1] at about the time that a comparison of the fundal pictures as observed with my monochromatic ophthalmoscope with those obtained with the so-called "red-free" ophthalmoscopes now in general use was to be made. In this way it was hoped to determine what merit, if any, an absolute red-free ophthalmoscope has over the others in which colored filters are used without particular attention to their red-free quality.



An absolute monochromatic ophthalmoscope.

The instrument consists of a lamp house (*A*) in which is incorporated a mercury vapor lamp with an exhaust fan and a holder (*B*) for the several filters: red, green, yellow, blue and ultraviolet.

The entire instrument is portable and can be used in any position and with ordinary alternating current. For fundal examination it is held in the hand as is the ordinary ophthalmoscope. The head (*C*) is taken from an old model De Zeng ophthalmoscope. A small model spectroscope is included with my instrument to insure the monochromatic quality of each of the filters used at the time of the examination of the eye-ground.

Of the various colors employed, green and particularly yellow gave interesting pictures, such as a clear view of minute blood vessels, exudates, hemorrhages and retinal nerve fibers.

METHOD OF USE

The light should be turned on for a minute before the instrument is used. The reason for this is that with the increase of the degree of heat generated by the light the maximum intensity of the color of the filter is obtained.

The next step is to insert the filter into the holder (*B*). It is imperative that unfiltered light never be used, or retinal damage will result. After the maximum intensity of color is obtained, the exhaust fan is turned on and the instrument is ready for use. If the fan is not turned on at about this time, the heat will become too intense and will extinguish the light. Five to ten minutes will then have to elapse before the instrument is cooled sufficiently and relit for further use. The multiple posts (*D*) safeguard the patient from an accidental burn.

CLINICAL APPLICATIONS OF THE INSTRUMENT

It is well known that ultraviolet rays are an aid during the extraction of certain types of cataract. Some surgeons use ultraviolet rays only after operations for cataract to determine if all the matter of the lens has been removed. I have, however, found monochromatic yellow of greater value in illuminating the field after extraction of a cataract and during capsulotomy than either ultraviolet or intense daylight, which is generally used. It is possible that for the same reason the yellow color may be found of value in gonioscopy.

I am studying microscopic unstained pathologic sections of eyes illuminated with the

1. Dr. Joseph I. Gouterman, medical corps, is now with the Armed Forces.

various monochromatic colors and comparing them with stained slides illuminated in the ordinary manner, to determine the relative merits of each process.

The instrument is easily adaptable for any of the procedures which have been mentioned.

The monochromatic ophthalmoscope may not entirely replace the regular ophthalmoscope for general use, but it will be of value in questionable fundal pathologic conditions by virtue of the fact that the color emitted absorbs certain colors in the retina, thereby making pathologic conditions stand out more prominently.

BILATERAL INFANTILE GLAUCOMA ASSOCIATED WITH BILATERAL HEMANGIOMA CONGENITALE (NEVUS FLAMMEUS)

Report of a Case

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Director of Eye Clinic, Ižhevsk Medical Institute, Ižhevsk, U.S.S.R.

I have had under my observation a case of an extremely rare condition, bilateral congenital hemangioma congenitale (nevus flammeus) associated with bilateral infantile glaucoma. A review of the literature and of the exhaustive bibliography cited by Ehrlich [1] have failed to reveal any case of a similar occurrence. It seems worth while, therefore, to report this case.

REPORT OF CASE

V. D., a boy aged 11 years had a dark red birthmark involving the scalp and the forehead except for a patch

Fig. 1.—Bilateral hemangioma congenitale (nevus flammeus) associated with bilateral infantile glaucoma.

of skin above the bridge of the nose. The birthmark extended downward to the left of the midline and involved the skin of the eyelid, the cheek, the nose and the upper lip, as well as the buccal mucous membrane and the palate. To the right of the midline the hemangioma involved the conjunctiva and the nose. The skin of the right cheek and the mucous membrane of the lips and the mouth showed no trace of the nevus. The birthmark characteristically followed the first two branches of the trigeminal nerve on the left side and the first branch on the right side (fig. 1). The contour of the lesion was highly indented. The localization of the birthmark had not changed since birth.

Vision was unimpaired until the age of 9, and the boy made good progress at school. Two years prior to his admission to the clinic the right eye became inflamed and painful. Vision became rapidly worse. During the last six months vision in the left eye deteriorated to a disastrous degree, and the boy had to discontinue attendance at school in the autumn of 1941.

The family history showed that his grandaunt had hemangioma congenitale.

Examination.—The boy was well nourished and normally developed, the internal organs showing no departure from normal. The Wassermann reaction of the blood and the Mantoux reaction for tuberculosis were negative. The blood pressure was normal. A blood count and urinalysis revealed no abnormalities. Roentgenograms of the skull indicated no pathologic change in the sella turcica.

Both eyes showed great degeneration. The right eye was completely blind; with the left eye he could distinguish fingers at 0.5 meter.

Right Eye: The eyeball was larger than normal along the anteroposterior axis, and projected anteriorly 3 mm. in advance of the left eyeball. The nasal halves of both lids were involved by the birthmark, which then extended to the bridge of the nose. The conjunctiva of the lids and of the folds was slightly hyperemic. The conjunctiva of the eyeball and the episclera were reddish violet, especially around the limbus. Examination with a magnifying glass indicated that the cause of this lividness was the dilatation of a large number of conjunctival and episcleral vessels, the increased vascularity being especially prominent around the limbus, where the sclera thinned out. The cornea measured 13 mm. in diameter; it bulged and showed a diffuse opacity. It was highly vascularized around the periphery. The vessels lay deep in the cornea, many being obliterated in places (as seen with the slit lamp).

The corneal sensitivity was impaired, and the anterior chamber was abnormally deep. The iris was dirty green and atrophic; the pupil was dilated and of irregular shape, with an uneven pupillary border, and did not react to light. The pupillary area was occupied by a cataract. The visual acuity of the right eye was

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From the Eye Clinic of the Ižhevsk Institute of Medicine.

1. Ehrlich, L. H.: Bilateral Glaucoma Associated with Unilateral Naevus Flammeus: Report of Case. Arch. Ophth. **25**:1002 (June) 1941.

zero. The eye was as hard as stone. The intraocular tension measured 65 mm. of mercury (Schiøtz).

Left Eye: The eyeball was normal in size and shape. The hemangioma involved the skin and conjunctiva. The sclera of the lower half of the eyeball was abnormally thinned and was perforated by tortuous, dark red vessels, which projected on to the surface. The cornea was 11 mm. in diameter and was transparent, its sensitivity being less than normal. The iris was light blue and of definite pattern. The reaction of the pupil was sluggish to light. The lens and the vitreous were transparent. The papilla of the optic nerve was atrophic, the vessels being displaced toward the nasal edge of the papilla. The arteries were hardly visible, only the veins remaining. On the retina the veins were varicose and tortuous. The choroidal vessels were not visible. The tension was 45 mm. of mercury (Schiøtz). The visual acuity was 0.005 to 0.01.

Systematic instillation of pilocarpine and physostigmine did not result in reduction of tension or improvement in vision. Consequently, there was no hope of effective surgical intervention.

The interest of this case lies in the fact that a bilateral hemangioma was associated with malignant bilateral infantile glaucoma, which had resulted in complete blindness at the age of 11.

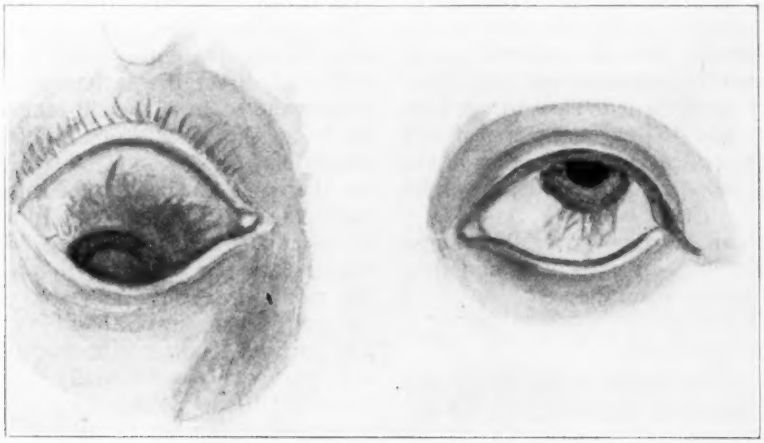

Fig. 2.—Appearance of the eyes in a case of bilateral hemangioma congenitale associated with bilateral infantile glaucoma.

The cause of glaucoma in this case, whether it was dilatation of a blood channel in the tractus uvealis, i. e., a hemangioma similar to that of the skin, resulting in distention of the eyeball with fluid, or whether it lay in impairment of the sympathetic innervation, is difficult to determine. It is certain, however, that there was a close connection between the glaucoma and the hemangioma and that both were congenital.

Ižhevsk Medical Institute.

BIOMICROSCOPIC SURGERY AND TREATMENT

HOWARD E. CRAWFORD, M.D., HILO, TERRITORY OF HAWAII

Little has been written regarding the use of the slit lamp and the corneal microscope as an aid to ophthalmic treatment. Berliner [1] mentioned their use in the removal of foreign bodies from the cornea. This use became apparent to me several years ago, since many foreign bodies are so small that they can hardly be visualized by any other method. Particularly in Hilo small spicules from the edges of sugar cane leaves commonly lodge in the cornea. These penetrate into the stroma and are nearly transparent; consequently they can be seen only by direct and indirect retroillumination. They may be multiple and can be removed only under magnification with the microscope. Otherwise, they are absorbed slowly, with ocular disability lasting from one to several weeks. Any foreign body can be removed more precisely from the cornea by this method. There is no need for excessive trauma. The exact direction of force to be used is easily determined. Small particles of rust, which are readily visible, can be removed with little difficulty.

If it is necessary to cauterize an ulcer under the foreign body, or any ulcer for that matter, it is cleaned out by using a small applicator—a toothpick is about the right size—around which a tiny wisp of cotton has been tightly wound. Such applicators should be sterilized in the autoclave prior to use. The point is applied to the defect and twisted until the exudate is removed. The chemical agent can be used on a similar applicator or on the bare wood and is applied exactly to the area over which cauterization is desired. For the removal of foreign bodies

1. Berliner, M. L.: Biomicroscopy of the Eye, New York, Paul B. Hoeber, Inc., 1943, pp. 1-553.

I prefer to use a 25 gage hypodermic needle which is fitted on the adapter of a Coakley antrum trocar for greater flexibility. Similar methods have been described previously.[2]

Before treating dendritic keratitis or corneal lesions resulting from other causes, it is often advisable to remove epithelium. This can best be done with a fine conjunctival forceps, although smaller pieces can be teased off with the needle.

Corneoscleral sutures, which are used in the extraction of cataracts, can be removed easily and accurately under biomicroscopic magnification. By ordinary methods it is easy to cut both sides of the loop and to leave a piece of silk buried. The exact application of the point of the scissors in the loop is not difficult under magnification.

Misplaced cilia can be removed easily. These are frequently light in color or broken and thus difficult to grasp unless magnified.

METHOD

The simplified universal slit lamp of Bausch and Lomb with standard magnification is the instrument which I use, but there appears to be no reason why others are not as good. The operator can use the right or the left hand, as preferred. The beam is directed from the side opposite the hand to be used, for instance, from the operator's left side if he expects to use the right hand. It is necessary that the hand be steadied by resting it against the left side of the patient's nose and the left cheek when working with the right hand on the patient's right eye and against the side of the head rest when working on the left eye. It is frequently necessary to have an assistant hold the lids apart. Before the hand is put in place the patient's gaze is directed to the position desired and the microscope is focused on the point to be treated. The operator can then move away from the microscope, place the hand to be used in position and direct the instrument near the cornea within the beam of the slit lamp. He then moves back to the microscope, and the instrument, which can be seen through it, is slowly brought to the spot to be treated and the necessary manipulations carried out. In working on cilia, it is convenient to employ the free hand to manipulate the lid while the forceps is held in the other, the microscope having been focused before. When only one hand is occupied the other can be used for fine adjustments of focus, which are necessary occasionally when the patient moves. Diffuse illumination is usually all that is necessary for the treatment of foreign bodies, but for fine particles focal, direct and indirect illumination may be required, depending on their size and transparency.

2. Harding, G. F.: Instrument for Removal of Foreign Body from Cornea, Arch. Ophth. **29**:134 (Jan.) 1943. Appelbaum, A.: Simplest Instrument for Removal of Foreign Body from Eye, ibid. **30**:262 (Aug.) 1943.

SUMMARY

The use of the biomicroscope in ophthalmic treatment has not been sufficiently emphasized.

The magnification obtained by it permits accurate treatment of foreign bodies and ulcers and in certain instances is of value in the removal of sutures and cilia.

Ophthalmologic Reviews

EDITED BY DR. FRANCIS HEED ADLER

DETACHMENT OF THE CHOROID

A CLINICAL AND HISTOPATHOLOGIC ANALYSIS

EDMUND B. SPAETH, M.D., AND PERCE DE LONG, M.D.
PHILADELPHIA

The clinical condition commonly spoken of as detachment of the choroid is probably a more common manifestation of a pathologic process in the globe than is generally considered. The literature relating to it is remarkably scanty. Its treatment (when applied in any given case) is confused and too often of no consequence, and even its pathologic characteristics and its various etiologic and anatomic aspects are controversial. Rycroft [1] recently called detachment of the choroid "a poor relation of retinal detachment" and stated that as such it "occupies a position of insignificance in textbooks, where it is as often as not ignored entirely, or briefly dismissed with a few words." It is apparently not a distinct entity, seen only after operations for cataract and glaucoma. It occurs not only with perforating surgical procedures on the eye but as the result of severe trauma to the eye; it may be either hemorrhagic or nonhemorrhagic, and it appears as a terminal phase in pathologic conditions of the uveal tract.

We believe that the underlying pathologic process in the choroid is the same regardless of whether the condition is serous or hemorrhagic or both, and that the immediate cause may be connected with (*a*) an intraocular surgical procedure; (*b*) traumatic perforation of the globe, either of the posterior or of the anterior segment; (*c*) trauma to the globe, without perforation, or (*d*) inflammatory changes, which may be acute but usually are chronic and of long standing.

In the examination of microscopic sections in connection with this study, it was necessary, first, to decide with reasonable exactness what constituted a pathologic condition and to what degree choroidal and perichoroidal separation are present not as the result of fixation and staining of the tissue (artefacts) but because of disease or of faulty intraocular mechanical situations. Many wholly normal eyes show some separation of the perichoroidal space from the sclera (even up to the ora serrata), with the suggestion of an albuminoid material lying between the choroid and the sclera—breaking up the perichoroid into lamellas—certainly only an artefact. Many sections examined had to be rejected for this reason, as not demonstrating pathologic detachment of the choroid. Our criteria for the presence of a pathologic process were: the degree of apparent lamellar formation and separation; the constant presence of an interlamellar, a subretinal or a subchoroidal fluid which coagulated with the fixative and took a stain [2]; the presence of cellular elements and other signs of trauma or of inflammation, such as red blood cells, dilated blood vessels and round cell infiltration; contiguous or adjacent lesion of the retina, and pathologic changes between the choroid and the sclera. Figure 1 illustrates the formation and separation of choroidal lamellas, a change which is probably largely an artefact. The section is from the choroid of an enucleated eye, removed because of progressive keratitis with long-standing iridocyclitis. The walls of the vessels are thickened. Chronic inflammatory areas lie immediately beneath the pigment, and the greatest formation of choroidal lamellas lies, properly, in the deeper layers of the choroid, close to the sclera. In this eye the retina showed an area of old degeneration and was completely detached. The picture in figure 2 was also considered within the normal. The eye had been enucleated because of continued, intractable hypertension with blindness. A few superficial hemorrhages lay in the choroid. The alterations in the choroid extended toward the left as a rapidly narrowing area of splitting

From the laboratory and clinical services of Wills Hospital.

Dr. Bernard Samuels and Dr. T. L. Terry gave assistance in the preparation of this paper, and Dr. Arnold Knapp made suggestions and offered constructive criticism.

1. Rycroft, B. W.: Choroidal Detachment, Brit. J. Ophth. **27**:283, 1943.

2. O'Brien,[9] citing Reese, discussed the suprachoroidal space, which normally contains a small amount of transudate and, therefore, is to be regarded as a lymph space.

of its structure, which undermined the ciliary body and freed it from the sclera. Figures 1 and 2 therefore illustrate a minimal pathologic change; the condition of the choroid, however, is probably not the true choroidal edema of the

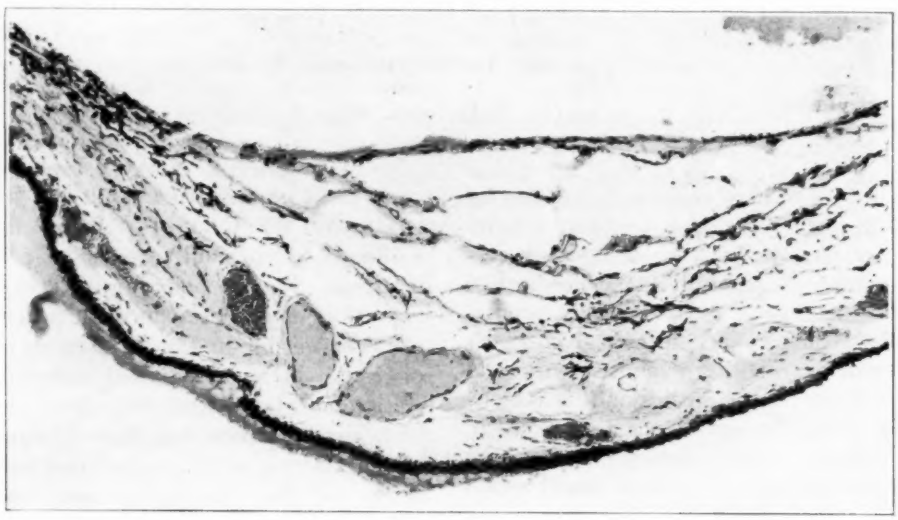

Fig. 1.—Lamination of the perichoroid, considered as an artefact.

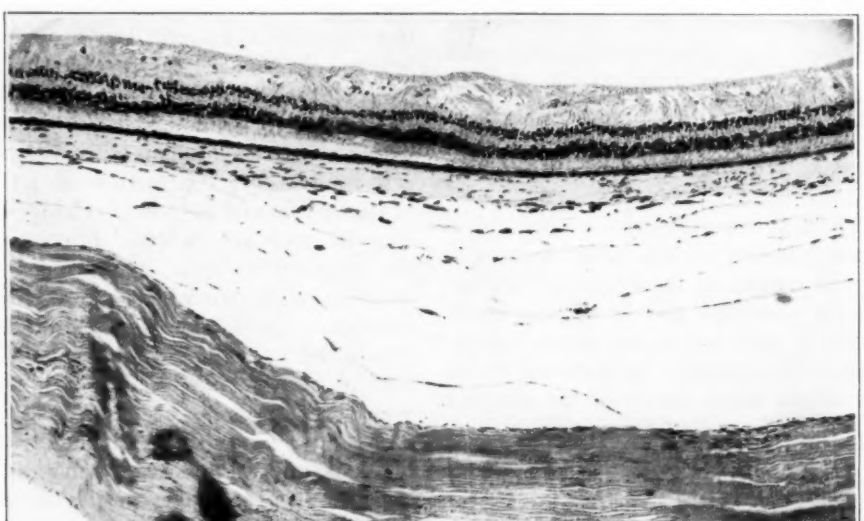

Fig. 2.—A situation similar to that in figure 1.

type under discussion. Figure 1 represents, perhaps, a borderline condition.

While we were engaged in the extensive and time-consuming study of many microscopic slides in the laboratory at Wills Hospital, at the suggestion of Dr. Arnold Knapp, one of us (E. B. S.) discussed at length with Dr. Bernard Samuels the mechanics of detachment of the choroid. Dr. Samuels was closely associated with Ernst Fuchs in histopathologic studies. He (Samuels) contributed generously from his notes and his personal memories of Dr. Fuchs's comments on this subject and gave us access to a large number of slides from the Hofrat professor's original preparations. The opinions expressed by Dr. Samuels were borne out by our observations. It was gratifying,

also, that our conclusions, as expressed in the second paragraph of this paper, closely parallel those stated years ago by Fuchs.

Actually, as has been reported frequently in the ophthalmologic literature, Dr. Herman Knapp was the first to see and record a detachment of the choroid. After an operation for cataract, he saw a dark, semiglobular projection in the vitreous body and mistook it, naturally, for a melanotic tumor. The eye was enucleated, and subsequent microscopic examination showed that the true condition was a "serous detachment of the choroid." Dor made the same mistake in 1934, but in a case of late choroidal detachment, occurring two months after corneoscleral trephining.

In many cases detachment of the choroid, whether or not it is suspected, cannot be seen during life because, for various reasons, the interior of the eye is not accessible to ophthalmoscopic study. Perforation of a globe after an ulcer, with sudden diminution of intraocular tension, or a massive hemorrhage into the vitreous due to trauma to the eye, but without perforation, are instances of such conditions.

Fuchs first expressed the conviction, which has recently been confirmed by O'Brien, that detachment of the choroid occurs frequently after operation for cataract. The incidence is high in cases in which the anterior chamber does not refill for a long time after the operation. One wonders, and logically, whether failure of the anterior chamber to reform may not be the result of a choroidal detachment (if so, a reversible process), rather than the choroidal detachment's being the result of the delayed reformation of the anterior chamber. If so, and in these instances, the choroidal detachment must have occurred before the reformation of the anterior chamber could play any role in its production. It is a fact that the choroid seldom becomes detached in cases in which the anterior chamber has once been reformed within a normal period, without event or previous complications, and the chamber is subsequently emptied as a result of incidental trauma. It may be that in such cases the choroidal arterioles and capillaries have already become conditioned to lower pressure levels, and hence the frequency of detachment is much less.

Certainly, after corneoscleral trephining detachment of the choroid is common. Actually, it seems, clinically at least, to be most common after this operation. This may be only apparent, since the fundus is usually examined earlier after operation for glaucoma than after cataract extraction. In cases of glaucoma the relation of preoperative hypertension, continued postoperative hypotension, failure of the anterior chamber to form again and duration of the choroidal detachment is interesting. Fuchs [3] commented that detachment of the choroid seldom, if ever, follows cyclodialysis. This observation is true with respect to serous detachment of the choroid, but not with respect to the hemorrhagic form. Also, Fuchs observed that choroidal detachment was much more frequent after iridectomy for acute glaucoma, and this statement seems to be supported by our present observations and by the results of our routine postoperative examinations. Fuchs described the condition in 11 cases after 14 iridectomies for acute glaucoma [4] (also cited by Rycroft [1]). According to Fuchs's earliest theory a rent in the perichoroidal space was necessary for the development of the detachment. A case will be presented later in which detachment of the choroid persisted for weeks after a corneoscleral trephination; the external wound healed completely, but external filtration was not set up and the anterior chamber did not reform. External filtration through the operative trephine opening did not become established until the choroidal detachment had disappeared. It seemed that a posterior subchoroidal drainage, toward the vortex veins, was the reason for the hypotension and that when this ceased, the anterior chamber reformed and external filtration took over the drainage. It is a fact, also pointed out by Fuchs, that the regions of the vortex veins themselves, in cases of the serous type of detachment, are not involved and that they limit the detachment, as though the veins bound down the choroid at their points of exit. This observation, hence, makes it permissible to wonder whether in such cases the presence of a choroidal detachment may not equally as often be the cause as the result of failure of the anterior chamber to reform. The situation is almost *post hoc, ergo propter hoc*.[5]

With the usual choroidal detachment following an operation for cataract, one can see, behind the plane of the pupillary aperture, with and sometimes without the ophthalmoscope, a smooth gray, semiglobular elevation, displaced somewhat to the temporal or to the nasal side. Such a lesion is to be differentiated from a detachment of the retina by its darker color and by the absence of folds or undulations. As the wound closes and the anterior chamber is refilled, the detachment disappears spontaneously, regardless of any so-called methods of treat-

3. Fuchs, E.: Ablösung der Aderhaut nach Operationen, Arch. f. Ophth. **53**:395, 1902.

4. Fuchs, E.: Ablösung der Aderhaut, Arch. f. Ophth. **51**:199, 1901.

5. To wit: the fallacy of arguing from mere temporal sequence the relationship of cause and effect.

ment. The explanation of the mechanics of its formation, according to Fuchs, is as follows:

When part of the contents of the eyeball is evacuated, as in a lens extraction, its loss may be compensated for by the entrance of air into the eye, or the scleral capsule collapses, by reason of its elasticity, to the extent which is necessitated by the diminution in the contents of the eye. When, however, this elasticity is insufficient, atmospheric pressure is transmitted through the orbital fat. The sclera has a tendency to resume its original form, as does a compressed rubber ball. As a rubber ball, when freed from the pressure of the hand, has the property of producing suction, so the rebound of the sclera causes a negative pressure to become operative in the interior of the eye; in consequence, there is a transudation of serum under the choroid. In proportion to the increase in the intraocular pressure as it regains its normal level, this serous detachment decreases, owing to the absorption of the fluid beneath it. With the closing of the wound in the eye, fluids within the vitreous cavity form again to raise the intraocular tension to its former pressure.[6]

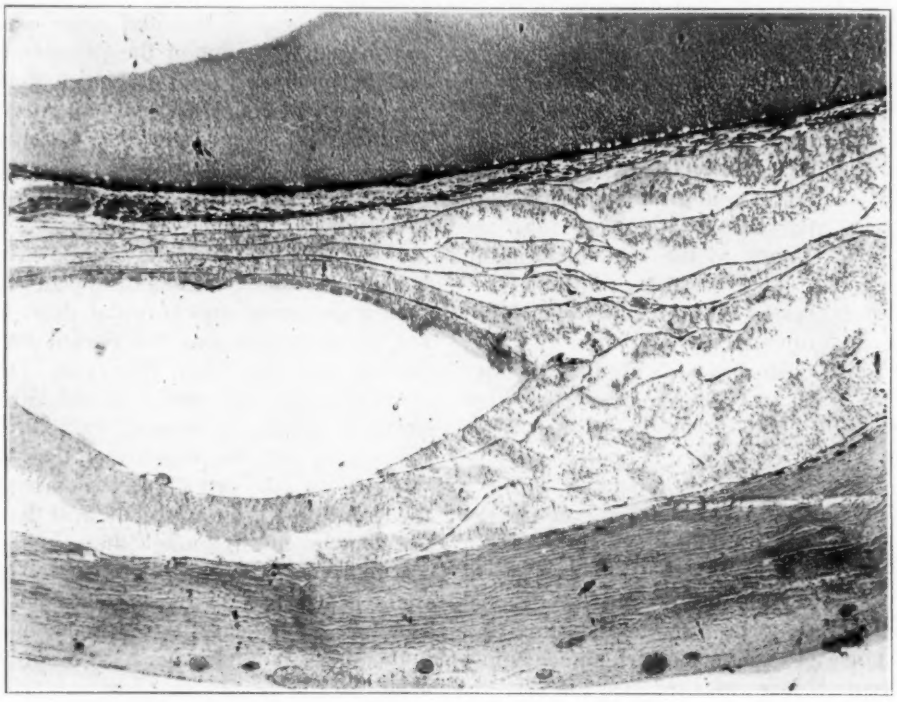

Fig. 3.—Enucleation following severe trauma to the globe.

This form of choroidal detachment is the first type in Fuchs's classification.

Fuchs's second type of choroidal detachment is the hemorrhagic, or the so-called expulsive, hemorrhage. All degrees of severity of this type may be seen. As an example, hemorrhagic suprachoroiditis, without, however, rupture of the retina or the internal limiting membrane of the retina, was seen recently after a basal iridectomy for glaucoma. Transscleral drainage confirmed the hemorrhagic origin. The other extreme is seen in cases in which the hemorrhage is so tremendous that the choroid is forcibly pushed against the vitreous body; the vitreous is then expelled from the eye, and the retina and the choroid follow. The mechanics operative here does not differ much from that producing choroidal detachment after operation, but without hemorrhage. When the vessels of the choroid are suddenly released from the external normal or increased pressure (as in cases of glaucoma) to which they have become conditioned, a greater quantity of blood enters them than they can hold; as a result they burst. A slide in Fuchs's collection showed the following condition: After perforation of a serpiginous ulcer in a case of glaucoma, there had escaped through the aperture, and lay in front of the eye, though still attached to it, a large sac filled with blood, the walls of the sac being formed by the everted prolapsed choroid (Samuels).

The third type of choroidal detachment of the choroid described by Fuchs is the form seen frequently in atrophic eyes. Apparently, the cause is similar to that of detachment of the retina seen frequently in the same eyes, namely,

6. This quotation, as well as the discussion of the four types of detachment, is a contribution to this study by Dr. Samuels. Corroboration with him emphasizes that close rapport which exists between surgery and histopathology.

traction due to cyclitic membranes. The lens becomes pressed against the cornea by these membranes, which include the ciliary processes, so that there is pulled toward the anterior portion of the eye a conglomerate mass composed of the ciliary body, the retina and the layers of the choroid. This form of detachment can be seen only in microscopic sections because an ophthalmoscopic examination cannot be made. The extent of the detachment is occasionally so great that the choroid, as a result of its own hydrops, as well as the general shrinkage of the globe, is many times as thick as normal. In this type of detachment, the choroidal fragmentation is

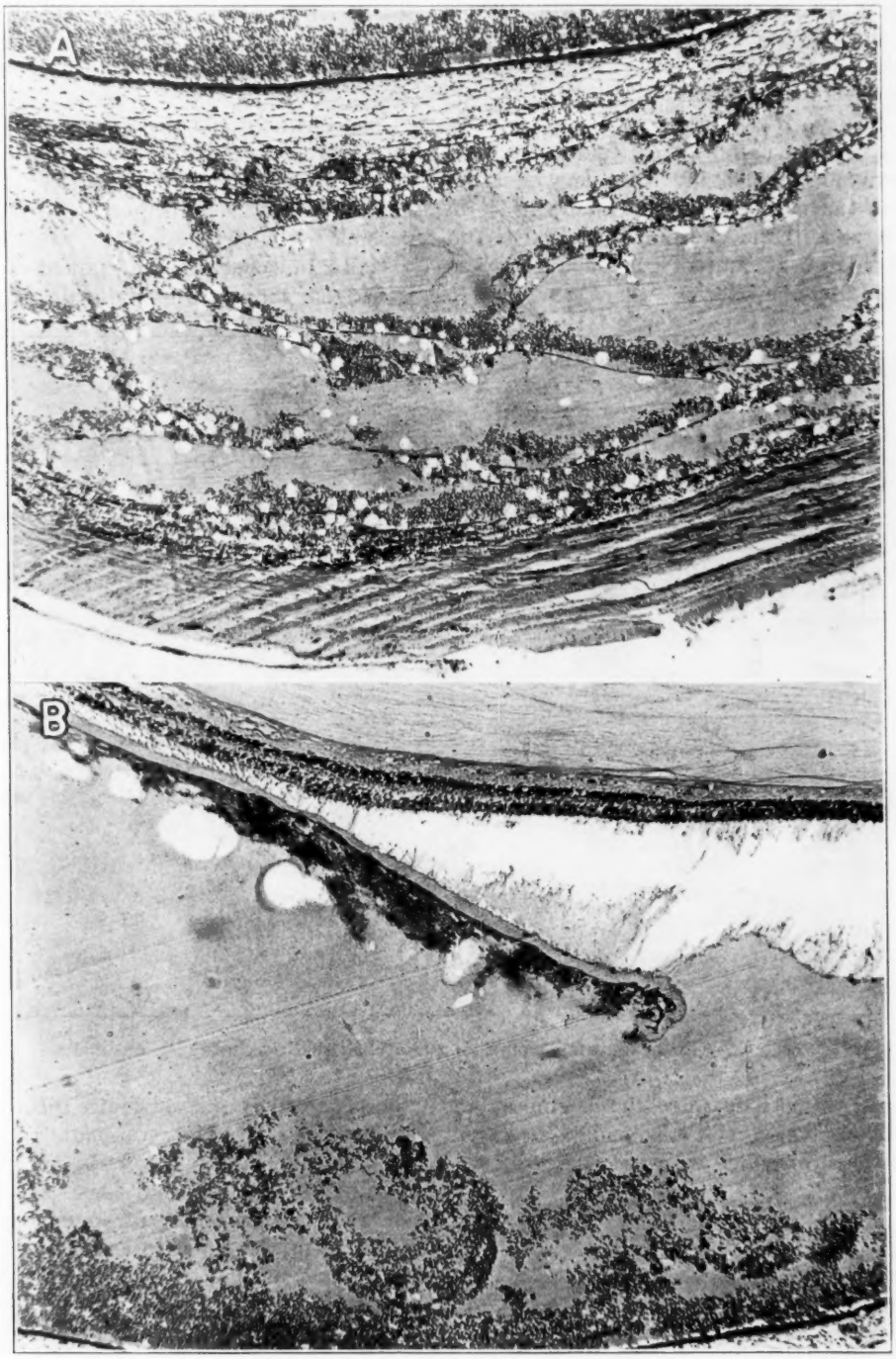

Fig. 4.—Traumatic rupture of the globe.

most conspicuous, and a densely staining interlamellar albuminoid fluid is present.

The fourth type of detachment, according to Fuchs,[3] is produced by the transudate present in an acute inflammatory process. Microscopic sections showing such a condition are not common; one such section was studied with Samuels, in which severe endophthalmitis followed a perforating injury, with formation of pus in the anterior chamber of the eye. Besides the periretinal exudates, which lay free, as well as in patches, in the vitreous, on the inner surface of the retina and in the choroid, there existed at one spot a large amount of transudate between the choroid and the sclera.

three subtypes: immediate, delayed and spontaneous. We feel that the so-called spontaneous detachment of Meller is an inflammatory condition; his immediate and delayed forms are also discussed in this paper under other heads.

CHOROIDAL DETACHMENT OF HEMORRHAGIC ORIGIN (CLASS 1)

There is no doubt that complete detachment of the choroid from the sclera may occur. The inverted choroidal sac, prolapsed after an intrachoroidal expulsive hemorrhage, illustrates the possible completeness of this detachment. Usually, however, the detachment of the choroid itself from the sclera is minimal, perhaps only in

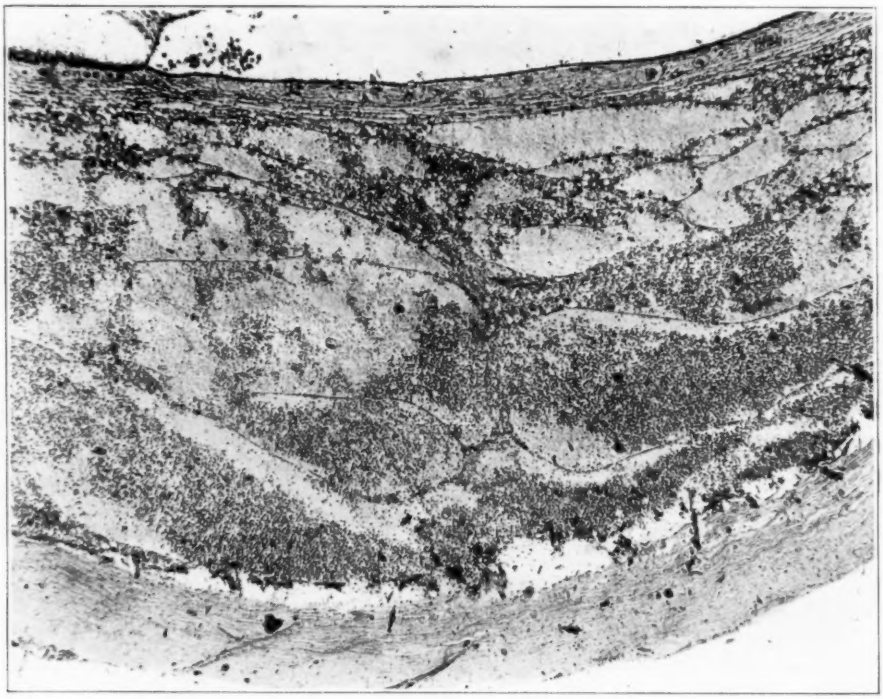

Fig. 5.—Old penetrating wound of the eyeball, with secondary glaucoma.

It is interesting that since the beginning of the present study, Rycroft [1] has called attention to a subdivision of which we were unaware.

Barkan lists four classes of choroidal detachment:

1. Tear of the ciliary body with the aqueous percolating into the suprachoroidal space. (Simple type).
2. Traction on the choroid and retina by organizing masses in the vitreous. (Traction type). [fig. 13].
3. Sub-choroidal haemorrhage. (Degenerative type). [fig. 9].
4. Massive choroiditis with sub-choroidal exudate. (Inflammatory type). [fig. 11].

In Meller's [7] classification (also cited by Rycroft [1]) Fuchs's first type was divided into

places, as can be seen in figure 6 *B*. Apparently, the process starts with traumatic rupture of one of the larger choroidal vessels. With continued bleeding, the perichoroid is split off from the sclera below through an extensive dissecting hemorrhage. In some cases the process may be self limited at this point; in others, as a result of continued bleeding, there occur perforations of the choroid, retinal detachment by the hemorrhage and even massive preretinal hemorrhages into the vitreous, undoubtedly passing through the retina.

Figures 3 to 7 illustrate such hemorrhagic forms.

Figure 3 is from an eye enucleated after severe trauma to the globe, followed by pain and blindness.

7. Meller, J.: Ueber postoperative und spontane Chorioidealabhebung, Arch. f. Ophth. **80**:170, 1911.

The globe was not ruptured. The section shows traumatic choroiditis with edema and the formation and extensive fragmentation of perichoroidal lamellas. The lamellas are separated from each other by a large amount of blood pigment. A large space indicates where a blood clot has fallen from the section. The greatest pathologic change is in the deeper portion of the choroid, the portion lying next the retina being less involved. A retinal separation appears in the upper part of the section. A subretinal transudate takes a dense stain.

Figure 4 is from a case of traumatic rupture of the globe. *A* shows massive edema of the choroid, with fragmentation and the formation and separation of choroidal lamellas, i. e., a suprachoroidal pathologic process, largely hemorrhagic. The perichoroidal fluid is in part serous and in part hemorrhagic. In *B*, another section from the same eye, the pathologic process in the deeper part of the choroid is largely hemorrhagic, with extensive hemorrhages, which are suprachoroidal as well, and densely staining albuminoid material. The retinal changes are profound. In this section transudation is an outstanding characteristic, being not only choroidal but preretinal.

Figure 5 is taken from a case of an old penetrating wound of the eyeball with secondary glaucoma. The edema of the choroid here is interesting in that, with the blood between the perichoroidal lamellas, it is perhaps responsible for the fragmentation and separation of the perichoroid. In this eye there were small areas of retinal separation, with small preretinal hemorrhages. The separation of the retina was most pronounced at the ora serrata. The greatest degree of hydrops seen in this hemorrhage-filled choroid was about the papilla, the edema extending laterally, toward the normal choroid.

Figure 6 is from a case of impact trauma to the globe without perforation. *A* is a photograph of the entire eye. *B* shows regions in which the choroid has apparently been lifted by the massive intrachoroidal hemorrhages, with edema when it was freed wholly from the sclera. *C* is a section taken from the uppermost part of the suprachoroid, the blood clot lying immediately behind the matted, detached retina, posterior to and slightly below the posterior pole of the lens. Careful scrutiny of *6A* will show the site of this section. The superior portion of *C* shows remnants of choroidal structure. The lower portion contains no remnants of choroidal structure.

Figure 7 is a section from an eye with old hemorrhages following an operation for glaucoma. The picture suggests the possibility of a former expulsive hemorrhage. The section shows no choroidal tissue as such—simply dilated vessels, round cell infiltration, many larger cells, which appear to be epithelioid, and blood pigment. The picture is probably one of late organization after subchoroidal or intrachoroidal hemorrhage. An extraocular hemorrhage below, outside the sclera, was probably associated with the enucleation. It seems hardly to be part of the intraocular process. The globe failed to show the presence either of the choroid or of the retina. They were undoubtedly expelled with the hemorrhage.

These microscopic sections of hemorrhagic situations are traumatic and postoperative and illustrate the second type of Fuchs's classification, that is, choroidal detachment of a hemorrhagic type.

The following 2 cases are illustrative of this form.

Case 1 is apparently an instance of pure choroidal hemorrhage.

CASE 1.—R. H., a man aged 20, when at a seashore resort with some companions was skylarking on a dock, approximately 20 feet (6 meters) from the water. He was pushed from the dock and struck the water on his face and chest. When he came from the water, it was seen that multiple subconjunctival hemorrhages were developing in the right eye. Examination of the fundus within an hour, through the dilated pupil, showed a dome-shaped elevation, starting at the equator and rising steadily to about 10 D. at the ora serrata. There were a few fine capillary hemorrhages in the retina over this elevation and several somewhat grosser ones in the otherwise normal retina contiguous to the elevated edge of this area. The rapidity of its development, the absence of any movement in the elevated area and the failure to find a retinal tear suggested a choroidal hemorrhage. The rapid and prompt subsidence of the entire condition, beginning within four days, made the diagnosis of retinal separation impossible. Some of the hemorrhages were still apparent on the retina when the patient was last seen, on the fourteenth day after the accident. The appearance of the fundus and the prompt subsidence of the pathologic process made impossible any diagnosis but that of choroidal hemorrhage.

In case 2 the hemorrhage not only was between the retina and the choroid, with perhaps considerable secondary edema, but was subchoroidal. The subsequent progress of the condition suggested that the choroidal hemorrhage originated from the simultaneous rupture of at least three of the four vortex veins of the choroid. This case illustrates beautifully the observation made by Verhoeff,[8] cited by O'Brien,[9] that angioid streaks in the choroid almost certainly indicate a previous separation of the choroid. The detachment in this case was accompanied by little, if any, primary retinal separation.

CASE 2.—C, a Negro boy aged 5 years, was struck in the left eye by the end of a broom handle. He was admitted to the hospital with severe edema of the conjunctiva and with the entire anterior chamber of the eye black with clotted blood. The sclera was not ruptured. A severe exophthalmos, present on admission, receded rapidly. The blood clot in the anterior chamber began to absorb, and on the tenth day after his admission one could see a massive elevation of the entire fundus. The optic papilla was visible in the depths of this funnel-shaped area. Multiple hemorrhages, many of them gross, were scattered over the surface of the retina. No retinal tear or disinsertion could be noted, even through the dilated pupil and

8. Verhoeff, F. H.: Nature and Origin of the Pigmented Streaks Caused by Separation of the Choroid, Tr. Sect. Ophth., A. M. A., 1931, p. 82.

9. O'Brien, C. S.: Detachment of the Choroid After Cataract Extraction, Tr. Am. Ophth. Soc. **33**:325, 1935.

with external pressure exerted at the limbus. The patient was given pinhole glasses, and was placed under treatment with atropine and dehydration. Transillumination from the depths of the orbit showed large, patchy areas of well defined shadows. The working diagnosis was that of massive, irregular choroidal hemorrhages, without rupture of the globe. The condition slowly and steadily receded without any treatment other than that mentioned. The recession of the process was interesting in that the areas of initial impairment noted with transillumination at the site of three of the vortex veins remained evident for some time, well on to six weeks. Between these areas the retina, now atrophic, receded to a normal position. The hemorrhages on the surface of the retina disappeared. The grayish pink of the normal fundus of a Negro boy was lost and was replaced by three radiating areas of massive angioid streaks, outlining respectively a large greenish area in the superior nasal region, a similar large inferior temporal area and a somewhat smaller, but similarly colored, inferior nasal area. Vision was lost entirely, as a result of the high degree of secondary atrophy of the retina, which was apparently due to the extreme damage to the choroid. The nerve head was entirely atrophic.

Case 3, also one of traumatic detachment, illustrates a slightly different type of damage, the retinal process in this instance not being hemorrhagic.

Case 3.—R. B., a boy aged 6, was struck on the left eye, apparently through the upper lid, by an arrow shot from a toy bow, at a distance of about 15 feet (4.6 meters). The boy was seen within an hour after the accident. There was a small laceration in the midline of the upper lid. The pupil was pinpoint. There was a crescent of blood cells in the lowest part of the anterior chamber, its greatest height being 2 mm. Visual acuity was grossly impaired but was not measured. The pupil was dilated with atropine. When the patient was seen six hours later, the entire anterior chamber was filled with fresh hemorrhage; a third hemorrhage occurred twenty-four hours later. These hemorrhages absorbed rapidly, so that the fundus could be seen by the fifth day after trauma. At that time the entire macular region was raised, the elevation measuring about 6 D.; the area was dome shaped and gray, with a pink center, which was slightly dimpled; in fact, the picture was that of the classic edema of contusio bulbi, though of unusually severe degree. There was rapid and steady recession of the pathologic process. In ten days vision with atropinization was 6/12, and pinhole vision was 6/5. The patient made a complete recovery.

The condition in this case must be considered as pure retinal edema. The anatomic distribution of the retinal and choroidal capillaries predisposes to pure macular edema in cases of such contusions. When central retinal necrosis occurs after trauma (as in a case of a hole in the macula), it suggests a pure retinal condition. The bright red appearance of the intact choroid, as seen ophthalmoscopically through a hole in the macula, confirmed the integrity of the choroid, with destruction of the overlying retina. The hemorrhages in the anterior chamber had probably nothing directly to do with the changes in the posterior segment. The time element, that is, the prompt recession and the rapid recovery of central visual acuity, was definite evidence against the presence of any choroidal hemorrhage.

The circulation of the choroid, as presented by Leber,[10] suggests that pure choroidal edema should be least common and least severe at the posterior pole of the eye; it should be much more frequent and more severe at the anterior periphery, that is, as the region of the ora serrata is approached. It is interesting that this assumption is usually borne out clinically.

Case 3 is presented as representative not of a choroidal but of a pure retinal condition, relevant to the subject only as it offers a contrast to the various factors, anatomic and mechanical, emphasized in the first 3 cases.

Of necessity trauma to the eye without perforation which results in rupture of the choroid

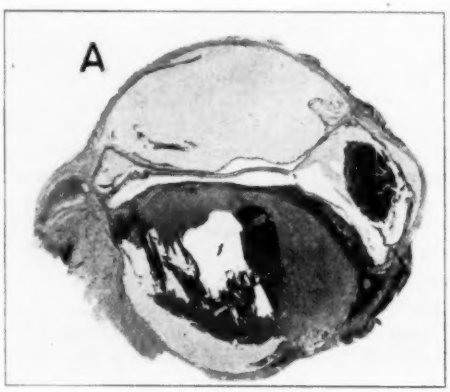

Fig. 6.—Impact trauma to the globe without perforation.

means hemorrhage. Direct trauma, with or without rupture of the choroid, but with disinsertion or laceration of the retina, results in separation of the retina, regardless of whether there is accompanying choroidal hemorrhage. In cases of trauma, both perforating and nonperforating, with retinal separation the immediate cause and/or accompaniment may be choroidal, retinal or subretinal hemorrhage. It is likely that the retinal separation would not persist unless preretinal elements, such as the vitreous and serum, found entrance into the subretinal regions through a laceration or disinsertion of the retina, with separation of the retinal layers from each other. This source of retinal detachment within the retina is commonly recognized. The two possible results of trauma offer an interesting study. From similar causes dissimilar and

10. Leber, T.: Anatomische Untersuchungen über die Blutegefässe des menschlichen Auges, Vienna, 1865.

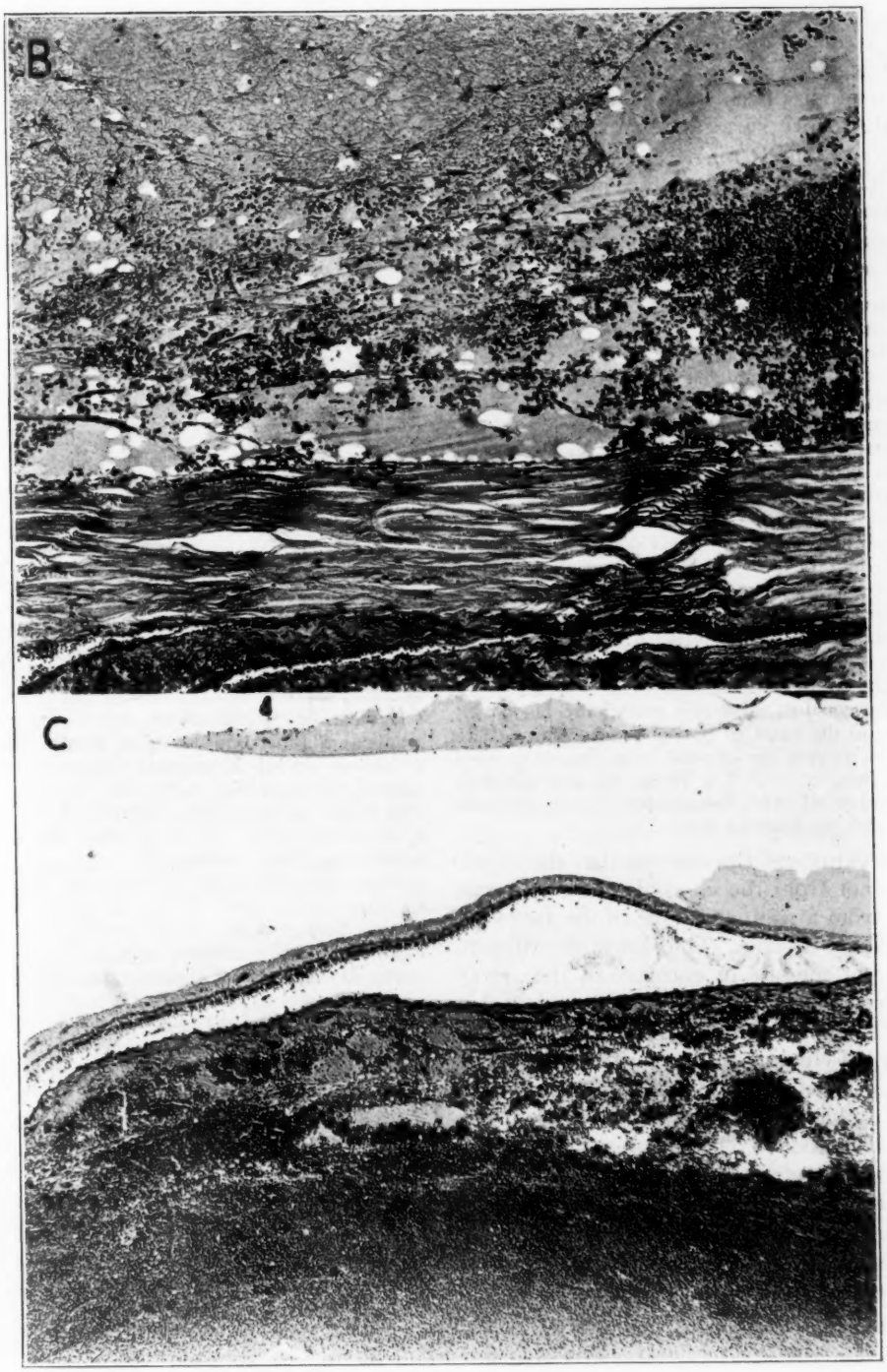

Fig. 6 *B* and *C*.—See legend on opposite page.

permanent anatomic changes and end results may develop. This is not uncommonly seen clinically. It is disheartening to find that after absorption of a large preretinal hemorrhage in the vitreous (which up to that time has obscured the ophthalmoscopic details) the patient has as well an extensive retinal detachment. In such a case the interval which has elapsed before the diagnosis could be made has been so long that the chances of any satisfactory surgical repair of the retinal separation are almost nil.

Samuels,[11] in discussing the anatomic conditions connected with nonexpulsive subchoroidal hemorrhage, that is, the hemorrhagic form of choroidal separation, stated:

> The amount of blood may be just enough to cause a low circumscribed detachment of the uvea far forward or it may be so large as to undermine the uveal tract on one side, from the scleral roll anteriorly to the margin of the optic nerve. [This is well illustrated in case 2 presented here. Instead of the long posterior ciliary artery's being ruptured in that instance, however (see later discussion), the three areas of opacity, the results of transillumination and the subsequent progress of the condition made it more likely that three vortex veins had been ruptured.] Usually the blood does not undermine beyond the limit of the perichoroidal space. As this comes to an end posteriorly at a considerable distance from the nerve head, it is exceptional to find blood under the choroid in the posterior segment of the eye. The vortex veins superiorly and inferiorly fix the choroid to the sclera [as Fuchs formerly stated], in the region of the equator. For this reason the blood clot accumulates on the nasal or temporal side, where there is nothing to prevent the choroid from detaching itself from the sclera. . . . The retina remains adherent to the choroid in all cases, because both layers are compressed against the vitreous body.

Samuels expressed the opinion that the bleeding comes not from the choroidal vessels themselves but from a rupture of one of the two long posterior ciliary arteries. The seat of the rupture is probably at the site of entrance of the artery into the perichoroidal space. In several of his specimens fragments of the walls of this vessel were observed clinging to the emissarium. In 1 case the adjacent stroma was infiltrated with blood, which had found its way there from the perichoroidal space. The distal walls of the ruptured vessel retract and degenerate, so that they no longer can be seen in the blood clot.

In comparing choroidal detachment due to the extravasation of blood and choroidal detachment due to transudation of serum, Samuels stated[11]:

> Extravasation of blood takes place rapidly; the transudation of serum develops slowly. Both are found in greater accumulation forward in the region of the ciliary body. A transudation is confined to the normal limits of the perichoroidal space, while a hemorrhage may undermine the choroid as far as the optic nerve [see case 2]. The two do not occur together. Bleeding, coming on abruptly, leaves no time or space for the transudation of serum. Eyes showing hemorrhage under the choroid are hard; those showing serum are soft. A fibrous thickening of the suprachoroidea persists after the disappearance of blood, but no membrane is found after the absorption of a transudate.

The following case is illustrative.

Case 4.—Mrs. R., aged 64, had bilateral cataract. An uneventful intracapsular extraction of the lens was done on the right eye. Some time later a similar operation was performed on the left eye. This operation, a simple extraction, was performed with the patient under anesthesia induced with solution of tribromoethanol, a peripheral iridectomy being made immediately after the section, and prior to extraction of the lens. This of itself was uneventful. Two conjunctival sutures were inserted after the section. As a dressing was about to be placed over the eye, one could see vitreous trickling from the external canthal angle. The lid sutures were opened; the wound was inspected, and a developing prolapse of the iris was immediately resected. The lids were closed, and a pressure bandage was applied for forty-eight hours. At the end of that time the anterior chamber was unformed; the lips of the incision were approximated, and one could see a domelike elevation of the temporal half of the fundus. The patient was taken to the operating room, and, with use of local anesthesia, the conjunctiva was incised and a posterior sclerotomy made, with a cataract knife, below the level of the lower margin of the external rectus muscle, approximately 14 mm. behind the limbus. A large amount of black, fluid blood was evacuated. Postoperative convalescence was interesting. The incision healed; the anterior chamber reformed, but throughout the rest of the period of hospitalization (approximately one month) there persisted a bilobed retinal detachment, situated temporally and toward the periphery, with one lobe above the other. The region of the macula remained free. The presence of a subchoroidal, or more likely an intrachoroidal, hemorrhage was undeniable. The sutures and the pressure dressing, with, perhaps, the quiet induced by the anesthesia, saved the eye from a catastrophic expulsive hemorrhage. With posterior sclerotomy this hemorrhage was evacuated satisfactorily. The recession of the choroid without simultaneous reattachment of the retina indicates a subretinal effusion of fluid from the vitreous, through the sclerotomy incision made in the retina. Enucleation was necessary one month later because of continued irritation and the development of photophobia in the opposite, normal eye.

In the process of disappearance of the hemorrhage, a picture appears which is similar to that shown in figure 7. Samuels, in discussing the histopathologic picture of expulsive and/or nonexpulsive subchoroidal hemorrhage and the manner of its disappearance, stated:

> . . . phagocytes are rarely encountered, as is common in the periphery of blood clots in the vitreous and aqueous. Nor do the erythrocytes break up into granules. No shadow cells appear. As long as the hemorrhage is present, the red blood cells may show little or no change. They may persist for weeks. The exact mode of their disappearance is not clear. Probably they undergo chemical change, being dissolved, and in this way are carried off by the fluids of the tissues. As

11. Samuels, B.: Postoperative Nonexpulsive Subchoroidal Hemorrhage, Arch. Ophth. **6**:840 (Dec.) 1931.

the quantity of blood diminishes, the capsule appears to contract or to collapse, so that when the lining finally coalesces merely a thickened membrane is left [fig. 7]. In some preparations a row or two of cells indicate the line of union, and in other instances no sign of fusion is present. In the end, the suprachoroidea is transformed over a greater or lesser extent into a thick, dense, avascular membrane free from pigment. Such thickening of the suprachoroidea is often mistaken for the organization of an exudate after suprachoroiditis, when, as a matter of fact, it represents the collapsed capsule that once surrounded a hemorrhage.

Light is thrown on this matter in the examination of an eye enucleated four months after an injury. The suprachoroidea was replaced over its entire extent, from the scleral roll anteriorly to the vicinity of the optic nerve, by a thick dense membrane [fig. 7]. This lies like a ribbon in the sections, completely detached from the choroid and the sclera. Running along its center here and there are lymphocytes and some granules of blood pigment, marking the last vestiges of the hemorrhage.

There is little doubt that hemorrhagic detachment of the choroid is due, first, and most commonly, to rupture of the long posterior ciliary artery and, second, and perhaps rarely, to rupture of one or more of the vortex veins. The first source applies almost universally to the operative opening of an eyeball; the second, perhaps most commonly, to traumatic perforation of an eyeball. In a third condition, trauma to an eyeball without perforation, hemorrhage may be from a vortex vein, from the long posterior ciliary vein, and, perhaps more rarely, from a choroidal artery or vein.

CHOROIDAL DETACHMENT FOLLOWING INTRAOCULAR OPERATIONS (CLASS 2)

So-called choroidal detachment which follows intraocular operation is still, in the final analysis, of traumatic origin. In this type of detachment, however, as compared with that just discussed, intrachoroidal hemorrhage is rare, and the detachment is due almost entirely to edema or to an increase in transudation. Reuling [12] and Groenouw [13] and Meesmann [14] expressed similar opinions, long before Fuchs had stated his concept of the mechanism. Verhoeff [15] stated he was not convinced, however, that the situation was so simple. He granted that the cause of detachment was the result of transudation of fluid from the choroidal vessels, as O'Brien stated, following opening of the eye and reduction of the intraocular pressure almost to zero, but he (Verhoeff) asserted that this fluid distended the perichoroidal space and compressed the vitreous. The persistence of the detachment, after healing of the wound, proved to him that fluid had been squeezed out of the vitreous by the displacement of the retina and the choroid.[16] This opinion seems to have clinical proof in the sequelae which appeared in some of the cases about to be presented. Certainly, with the resulting trauma to the choroid, the explanation accounts satisfactorily for the angioid streaks not uncommonly seen after detachment of the choroid.

Histologic study of such lesions is not as common as is their clinical observation. Many of them, as O'Brien has shown conclusively, run a fairly brief and uneventful course; others recede rather slowly. Less commonly, they have complications. Choroidal and suprachoroidal hemorrhage may accompany the choroidal edema. Atrophy of the choroid and retina may result, probably owing to the extensive damage to the choroid. The angioid streaks, when they appear, suggest that choroidal damage has occurred; also, as Rycroft stated, if the anterior chamber remains unformed for any great length of time, the danger of synechia in the anterior angle is serious.

Choroidal detachment following a cataract operation is not always a simple, uneventful sequel of the surgical procedure. The following cases are illustrative.

CASE 5 (this case is but one of many similar, and uneventful, instances).—Mrs. W., aged 64, had bilateral senile cataract. The state of the cardiovascular-renal system was satisfactory, and there was no hypertension or diabetes. A combined extraction was performed on

12. Reuling, G.: Ablösung der Chorioidea in Folge von Cataract-Operation mit Glaskörperverlust, Arch. f. Augenh. **1** (pt. 2):186, 1869-1870.

13. Groenouw, A.: Zwei Fälle von Aderhautablösung (scheinbarem Choroidealtumor) nach Cataractoperationen mit spontaner Heilung, Arch. f. Augenh. **20**:69, 1889.

14. Meesmann, A.: Experimentelle und anatomische Studien zur Frage der Aderhautabhebung, Arch. f. Augenh. **90**:69, 1921.

15. Verhoeff, F. H.: Scleral Puncture for Expulsive Subchoroidal Hemorrhage Following Sclerostomy: Scleral Puncture for Post-Operative Separation of the Choroid, Ophth. Rec. **24**:55, 1914; Pathogenesis of Glaucoma, Arch. Ophth. **54**:20, 1925; footnote 7.

16. Lindner, again in 1936, expressed the belief that this plasmoid intraocular fluid, seeping through the vitreous, produced shrinkage of the vitreous by chemical action, and that this factor of shrinkage of the vitreous had much to do with choroidal detachment (Lindner, K.: Zur Klinik des Glaskörpers; die Zusammenziehung des Glaskörpers, Arch. f. Ophth. **135**:332, 1936; Zur Klinik des Glaskörpers; die seröse Aderhautabhebung nach Leckwerden des Augapfels, ibid. **135**:462, 1936). Other investigators who might be mentioned are H. Knapp (Die intraocularen Geschwülste nach eigenen klinischen Beobachtungen und anatomischen Untersuchungen, Carlsruhe, C. F. Müller, 1868); Haab (Ueber Scheingeschwülste im Augeninneren, Beitr. z. Augenh. **1**:103, 1891); C. D. Marshall (Detachment of the Choroid, Tr. Ophth. Soc. U. Kingdom **16**:98, 1895-1896); Velhagen (Ein Fall von Scheingeschwülste im Augeninneren nach Cataract-extraktion, Centralbl. f. prakt. Augenh. **21**:363, 1897), and Meller.[7]

the right eye, without complications. One year later a similar operation was done on the left eye. On both occasions an intracapsular extraction was attempted but a capsulotomy extraction was done instead because of rupture of the capsule prior to the dislocation of the lens. The patient was discharged from the hospital twelve days after the operation, apparently without examination of the fundus. Two days later, at the time of her first visit to the office, one could see in the superior nasal quadrant, extending from the equator to the ora serrata, an area of so-called choroidal detachment. A notation of the lesion was made on the record, but the patient was not informed of the situation. Six days later the detachment had disappeared wholly, without any residuals. Vision with correction was 6/5 in each eye, with a normal-appearing fundus.

CASE 6.—Mrs. R., aged 52, was blind in the left eye, as a result of an old trauma. She was seen in consultation forty-eight hours after a corneoscleral trephination, performed because of simple, noninflammatory glaucoma. The pupil was semidilated, the anterior chamber unformed and the cornea clear. The entire temporal half of the retina bulged forward in a large gray dome, the apex of which seemed to be on a level with the plane of the pupillary aperture. The area of elevation lay close to the nerve head temporally and extended above and below it, resembling the horns of a crescent moon. The superior nasal portion of the retina appeared normal. The bulbar conjunctiva about the trephine flap was conspicuously edematous. The external rectus muscle was detached and the line of the ora serrata determined. A series of scleral punctures was made 4 mm. behind the ora serrata, extending from the external edge of the superior rectus muscle to the external edge of the inferior rectus muscle, the line forming an almost complete half-circle. With the tip of a cataract knife, the scleral punctures were carried through the sclera. The puncture at about 10 o'clock showed a small amount of black, fluid blood, and at 7 o'clock a large quantity of black, fluid blood poured out through the sclerotomy opening. Additional punctures were therefore made behind this point, almost to the external limits of the insertion of the inferior oblique muscle. The external rectus muscle was reattached, and a pressure dressing was applied for forty-eight hours. Examination of the fundus at that time showed a notable recession in the elevation of the retina but no change in the area of involvement. One week later the level of the retina had become normal everywhere except for a grayish, shining dome in the neighborhood of termination of the long posterior ciliary artery. When the patient was seen one month later, one could see a large irregular half-ring of choroidal atrophy, which seemed to indicate the limits of the original choroidal lesion: No signs of the sclerotomy punctures were present. Vision was 6/9, and the field was full; no pathologic condition in the nerve head or in the peripheral nasal portion of the retina was visible.

One wonders whether the choroidal detachment in this case was due to rupture of the long posterior ciliary artery or to combined hemorrhage and transudation (see statement by Samuels, page 226). The immediate postoperative convalescence was uneventful. Two years later an intracapsular extraction was done for subsequent formation of cataract. Subsequent examination of the fundus showed that the irregular ring of choroidal atrophy was still present as an irregular crescentic line of pigmentation, with contiguous areas of depigmentation. There must have been an acute folding of the choroid at this point.

Case 7 suggests that extensive and progressive choroidal atrophy was a complication of the postoperative situation.

CASE 7.—Mrs. M., aged 60, with bilateral simple, noninflammatory glaucoma, had moderately severe hypertension and emotional instability. She had recently been widowed. There was apparently some renal damage. Vision was limited to mere light perception in the right eye, and was 6/60 in the left eye, with a cut in the inferior nasal field. The lens showed changes in the anterior cortex in both eyes, and the details of the fundus were barely visible in the left eye. The position of the nerve heads, which were just discernible, suggested glaucomatous cupping. No details of the fundus could be seen in the right eye, owing to the high degree of pathologic change in the cortex of the lens. Corneoscleral trephination, with complete iridectomy, was done on the left eye, without complications. No observations on the fundus could be made thereafter, but the early and marked immediate contraction of the nasal field above and below suggested either a high degree of choroidal detachment or immediate loss in the superior field following the operation for glaucoma, the result either of injury to the nerve bundle or damage to the retinal vessels. Within four weeks, however, the field widened to that present prior to operation. Continued impairment of vision due to progressive changes in the lens necessitated removal of the lens, six months later. An intracapsular extraction was done, without complication, section being made in the cornea, anterior to the limits of the filtering bleb at the site of trephination. A postoperative pathologic process was seen in the fundus, exactly similar to that in cases 6 and 9, that is, a yellowish red line of demarcation, irregular, but smoothly undulating from 1 to 5 o'clock—its most posterior portion a few millimeters behind the equator. The posterior edge of this line was sharply outlined, with fine granular pigment along each side, and between this and the ora serrata the appearance of the choroid suggested diffuse atrophy. The color in this region varied from pale red to gray, with fine clumps of pigment. The field of vision over an interval of three years has shown conspicuous progressive contraction, corresponding to this portion of the retina and the choroid. The macula is barely involved at present. Vision is 6/100, and with a telescopic lens it is 6/15. The ocular tension remains between 14 and 18 mm. of mercury (Schiøtz).

In case 8, one of intensely acute secondary glaucoma, apparently the result of a pathologic condition of the retinal vessels, the choroidal detachment was the most extensive in our experience.

CASE 8.—Mr. S., aged 50, a tailor, had always been in good health. A sudden attack of intensely severe, acute inflammatory glaucoma developed in the left eye. Moderate arterial hypertension had been present for some time. Forty-eight hours after his admission to

the hospital a basal iridectomy was done without complication and forty-eight hours later the fundus was examined because the patient complained of a continued high degree of visual impairment. The external results of operation were satisfactory. The preoperative tension of 80 mm. of mercury had dropped to 54 mm. prior to the iridectomy, and the tactile tension seemed normal at the time of the first examination of the fundus. The cornea was clear, but the anterior chamber was still somewhat shallow. With the ophthalmoscope, one could see two huge, portiere-like folds, which filled the entire medial and lateral portions of the vitreous chamber. Each fold had a sharp, precipitous edge, and, the disk and the macula were obscured by these elevations. The superior retinal artery and the retina contiguous to it could not be seen. This is important in view of the subsequent observations in the case, but at this time the examiner was unaware of anything significant. Recession of the choroidal involvement was rapid. The first determination of the field of vision showed almost complete inferior altitudinal hemianopsia, the macula being barely spared. The field was not consistent with the fundic picture. Further recession of the choroidal edema revealed complete permanent occlusion of the superior temporal retinal artery, and it was assumed that this vascular situation was the cause of the sudden, intense acute glaucoma. The patient was kept under observation for two years. Because of a slow, but steady, elevation in ocular tension, a cyclodialysis was then done. Detachment did not again occur. The condition has now been quiescent for five years, the ocular tension at no time after the cyclodialysis being above 22 mm. of mercury. The altitudinal hemianopsia has remained stationary. Certainly, the retinal vascular situation of itself did not play any role in the development of the hydrops of the choroid, but a general pathologic process of the arterioles, specifically, the preexisting disease of the choroidal vessels, may have been related to the detachment.

Case 9 is an interesting demonstration of choroidal detachment with grave hypotension, in which sequelae suggested the presence or development of bilateral mild, low grade uveitis. At no time could one surmise this from the appearance of the iris, the cornea or the anterior chamber. The late vascularization of the anterior capsule of the lens, the initial hypotension in the left eye, the rapid development of the complicating cataract and the inexplicable return of the glaucoma in the left eye seem to be more than interesting coincidences. We feel that uveitis may have a not inconsequential role in the production of so-called choroidal detachment. In this case, however, it is uncertain whether the uveitis preceded or followed the operation for glaucoma.

Case 9.—Dr. W., aged 62, had bilateral simple, noninflammatory glaucoma. The general physical condition was only fair. The patient was under the care of his general medical adviser because of vascular instability. Several episodes during the preceding year suggested early myocardial impairment. A corneoscleral trephination, with peripheral iridectomy, was done on the right eye, and ten days later a similar operation, equally uneventful, was performed on the left eye. Eight days after the first operation examination of the fundus of the right eye showed a gray, elevated, smooth-domed area of so-called choroidal detachment, in the form of an inverted V. The nasal and temporal areas were of about equal extent, the involvement including a third of the peripheral temporal portion of the retina and slightly more of the nasal portions. Spontaneous and rapid recession occurred, without any permanent changes in the fundus. Recovery was almost complete at the time of the patient's discharge from the hospital.

Six days after the operation on the left eye the picture was similar to that in the right eye, but we do not know how long it had been present. The patient returned to his home ten days later. The so-called choroidal detachment on the left side remained unchanged for approximately six weeks. Rest in bed and dehydration had as little effect on its course as did the resumption of his normal physical activities.

In this case an external filtration blebs did not appear at the trephine opening until the choroidal detachment had receded. After recession of the detachment a large multiloculated filtering cicatrix developed. After recovery there was apparent in the fundus a faintly outlined, yellowish gray line of choroid streaks, one edge of which, forming the limit of the detachment, was sharply outlined. The other edge was indistinct and faded off imperceptibly into the remaining structures. The appearance was much like that of angioid streaks of the retina. There was little doubt that the detachment was choroidal, the result of a long-standing disturbance of the choroid. The lens of this (left) eye became rapidly cataractous. It was removed (by intracapsular extraction) through an incision in the inferior portion of the limbus, without any untoward event. This operation, which was performed one year after the corneoscleral trephining, was followed by a similar detachment of the choroid, though not as extensive and of only short duration. The glaucomatous condition returned shortly, even though the filtering bleb above was functioning. It had not been disturbed by the cataract extraction. Corneoscleral trephining was repeated at 6 o'clock on the limbus, without success. The eye is now sightless, though without pain, and tension is 60 mm. of mercury (Schiøtz). The lens of the right eye is now becoming cataractous, though vision is still 6/15. Recently, a fine network of superficial blood vessels has developed in the anterior capsule of the lens. The vascularization does not arise from the arteries of the iris. Dilation of the pupil with eucatropine hydrochloride showed these vessels appearing on the anterior surface of the iris from the equator of the lens, presumably in the region of the ciliary body. The iris is normal, and there is no pathologic condition of the cornea. Ocular tension remains at 16 mm. of mercury (Schiøtz).

Case 10 suggests that detachment of the choroid may have a damaging effect on the lens through the development of low grade uveitis. Certainly, in the 2 cases presented (9 and 10) no signs of uveitis preceded the operation for glaucoma. The surgeon who operated on the left eye in case 10 assured us that there had been no uveitis prior to that operation. The first corneoscleral trephining was followed by failure of the anterior chamber to reform and by a huge choroidal detachment. The chamber did not form for over a month, and the detachment did

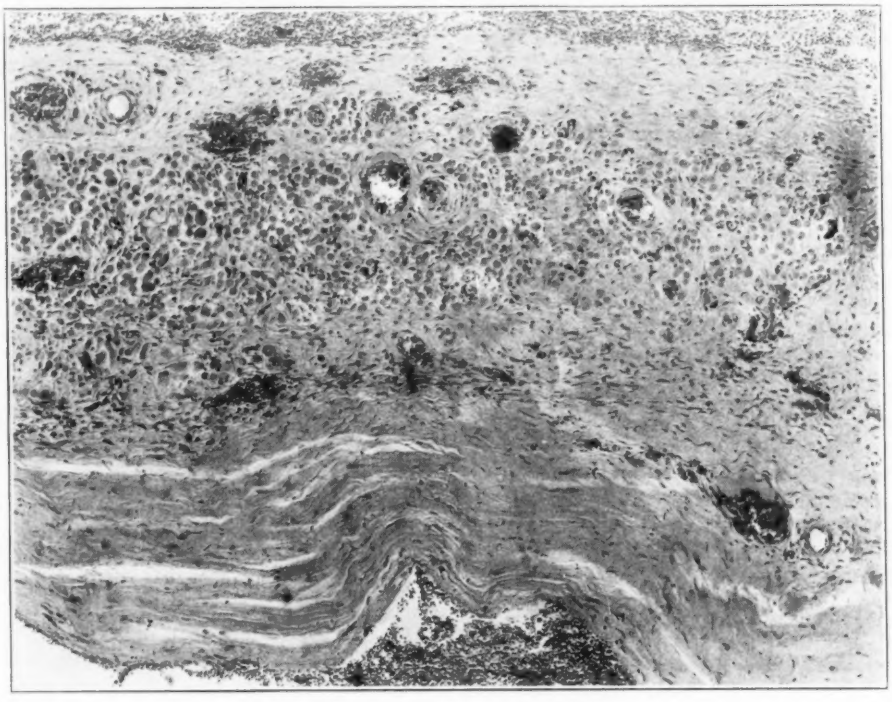

Fig. 7.—Late organization following expulsive hemorrhage.

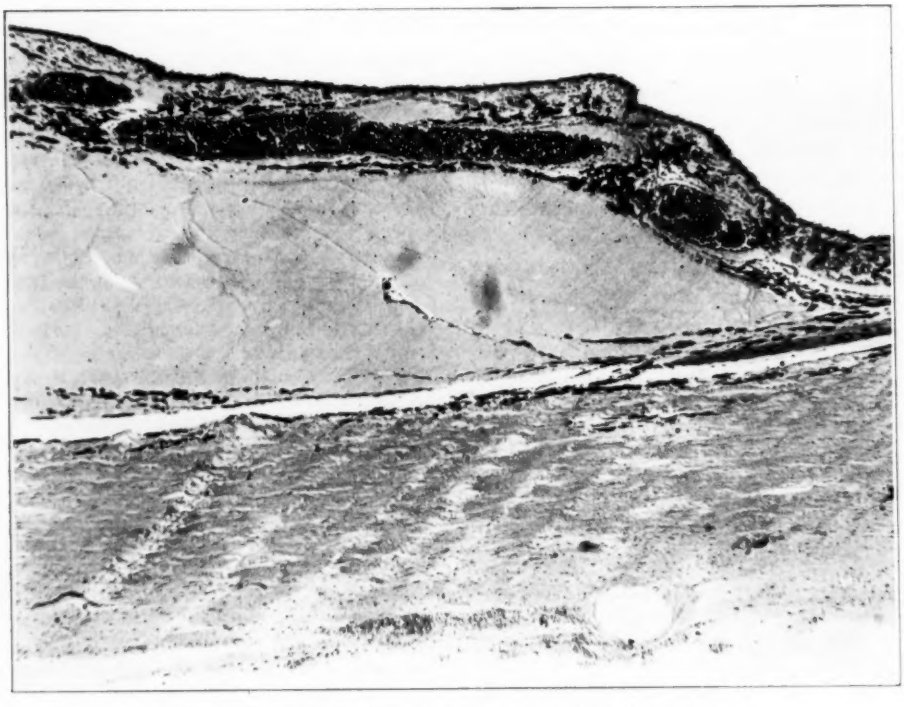

Fig. 8.—Choroidal edema following operation for glaucoma.

not recede until after the anterior chamber had formed.

Case 10.—Mrs. McD., aged 60, was first seen one year after a corneoscleral trephination on the left eye had been done in another city for simple, noninflammatory glaucoma. Vision in the right eye was 6/6 partly, with the intraocular tension slightly below 30 mm. of mercury (Schiøtz). A corneoscleral trephining was done on the right side, with no complications. (The history of the immediate postoperative convalescence of the left eye was obtained from the surgeon.) Vision was slow in clearing after the second trephination, and the patient was hospitalized for almost a month. When she was first seen, less than a year after her first operation for glaucoma, the lens in the left eye showed a typical picture of developing complicating cataract. On the posterior surface of the lens was a diffuse quartzlike or limestone-like opacification, with a faint yellow tinge, and a similar opacity appeared at the periphery of the lens in the anterior subcapsular zone. There was a rapid and steady increase in the pathologic process in the lens. Vision is now less than 6/100, and the intraocular tension is between 10 and 20 mm. of mercury. There is no lesion of the iris, cornea or anterior chamber. The field of vision is apparently normal. Examination of the right eye revealed no significant change in the lens. Measurement of the field of vision in this eye showed that recent involvement of the nasal fields had necessitated the operation for glaucoma. We can say with reasonable exactness that the first trephining was not accompanied by any surgical damage to the lens itself. The progress in the case, however, and the striking dissimilarity in the course of the disease in the two eyes are significant in support of our opinion that postoperative choroidal detachment at times may be accompanied by uveitis and at others may be the cause of such a condition. The anterior chamber in the second eye to be trephined failed to reform for twenty-one days, though no hydrops of the choroid was evident.

The following 2 cases are interesting in that in each a choroidal and a retinal pathologic process were present.

Case 11.—F., aged 28, a linesman for an electric company, while sectioning a cable with a power wire cutter, was struck in the eye by a piece of the cable. On his admission to the hospital, he showed a laceration of the cornea just within the limbus at 1 o'clock, with a prolapse of the iris and a badly damaged lens. Roentgenographic localization showed a piece of steel wire, about 1 cm. in length, lying in the vitreous chamber, between the equator and the ora serrata. A keratome incision was made; the prolapsed area of the iris was resected; the fragments of the lens were washed from the wound, and the steel was extracted by a magnet, i. e., carried up across the surface of the iris and then removed from the anterior chamber. The operative wound was closed with a conjunctival flap. The patient made an uneventful recovery except for an area of detached choroid, which had receded wholly when he was discharged from the hospital, with the eye quiet. Vision at that time was 6/45 with a temporary, or trial, aphakia spectacle lens. Three months later the patient returned to the hospital with an area of retinal detachment overlying the former region of choroidal detachment. The sequence of events here is significant, in view of Rycroft's recent discussion. Now, however, one could see through the coloboma of the iris, even with oblique illumination, a linear rent in the anterior portion of the detachment, starting close to the ora serrata and extending across the equator, i. e., parallel with the antero-

Fig. 9.—Perichoroidal detachment, with separation of the perichoroid, and subretinal transudates.

posterior meridian of the eye. The original so-called choroidal detachment had been bulbous, firm and without movement of any kind; it was present at the time of the first dressing and receded slowly, but spontaneously. The retinal detachment was gibbous and full. The choroidal detachment in this case was not due to subchoroidal hemorrhage. There was no choroidal or retinal laceration prior to the patient's first discharge from the hospital. Removal of the foreign body was by the anterior route, and the retinal separation was not

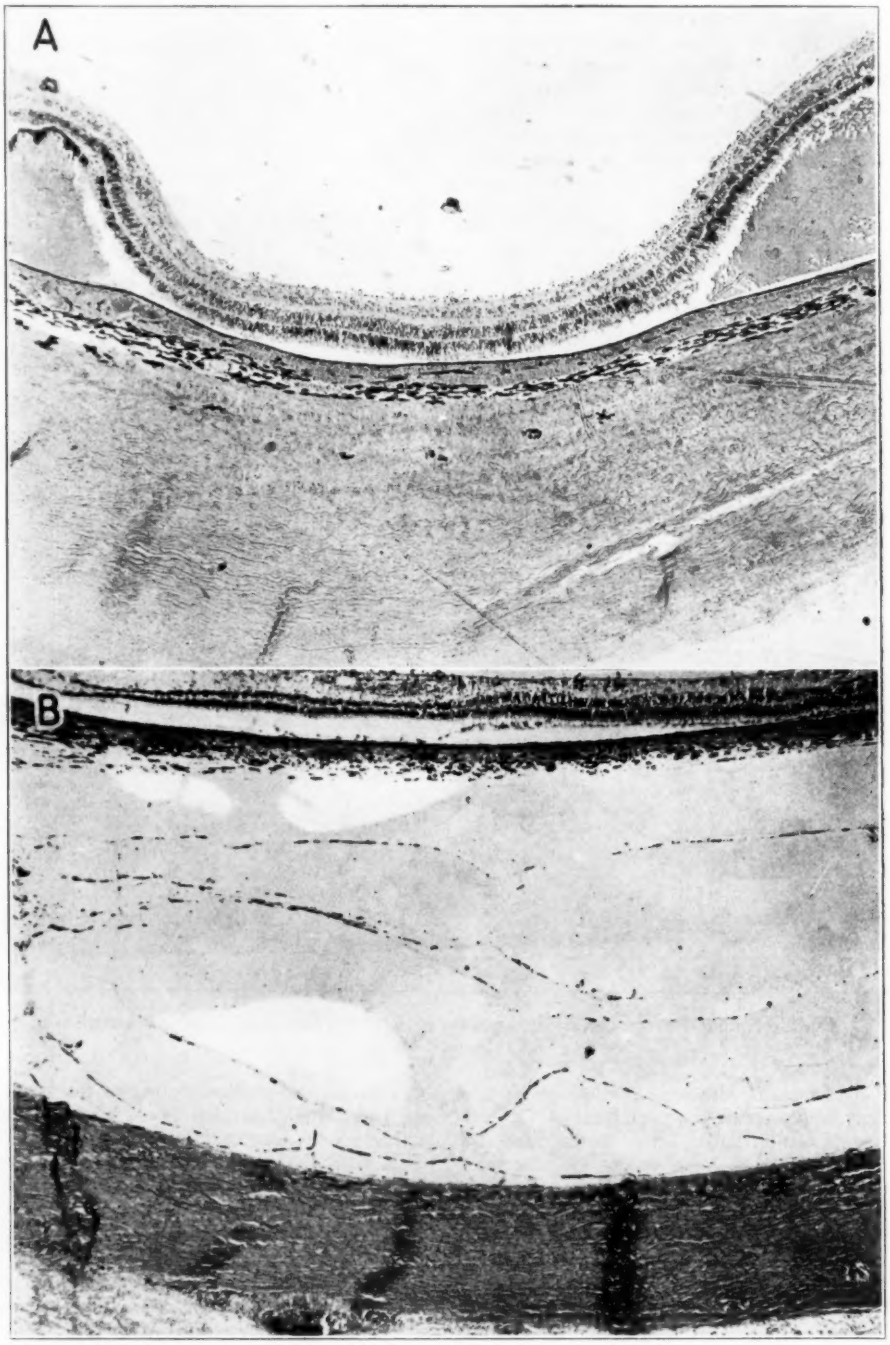

Fig. 10.—*A*, discrete subretinal transudates; *B*, portion of the area of choroidal detachment.

flaccid, moved independently of and actively with the movements of the eyeball, had a demonstrable tear and responded to operation completely, with satisfactory results. Final vision three months later was 6/15 partly with the aphakia spectacle lens. The field of vision was produced by sclerotomy. The choroidal detachment was the result of trauma and a surgical procedure; the retinal detachment may have occurred as a result of the choroiditis (uveitis) set up by the original damage to the choroid.

CASE 12.—Mrs. R., aged 62, had lost her right eye from an injury early in life. The left eye, when she was seen in consultation, showed an inferior choroidal detachment, which had appeared after an apparently uneventful recent corneoscleral trephining. The lens was mildly cataractous, and it was difficult to determine the exact condition present. Careful questioning of the patient failed to show whether the lesion was a true retinal detachment with glaucoma, whether it had been present prior to the trephining or whether it was a so-called choroidal detachment. The weight of evidence seemed to favor the last. The attending ophthalmologist was advised to consider it as such and to keep the patient under observation. Six months later word was received that she had been admitted to the same hospital for extraction of a cataract. She was examined prior to this operation, but the details of the fundus were not visible. Determination of the field of vision revealed nothing significant. The patient had fair light perception and good light projection. Extraction of the lens was uneventful, and several days later a careful examination of the fundus was made. In the region of the former choroidal detachment a similar situation appeared. At first glance, and without knowing the history in this case, one would have considered the diagnosis of choroidal detachment proper and plausible. Transillumination revealed impairment in the transmission of the light. The diagnosis, therefore, was that of an old, stationary retinal detachment, with perhaps an unrecognized neoplasm as the cause of the detachment. If not this, the findings on transillumination would be difficult to explain. A retinal tear was not seen. Ten days or two weeks later transscleral diathermy punctures were made to determine the presence of fluid and to obtain a specimen for microscopic examination for the presence of tumor cells. The subretinal fluid did not flow freely; it was xanthochromic, somewhat viscous and of a sticky, stringy consistency. Microscopic diagnosis was negative for tumor. The condition was considered to be an unresolved subchoroidal hemorrhage (intrachoroidal and/or perichoroidal), dating from the first operation, with some organization

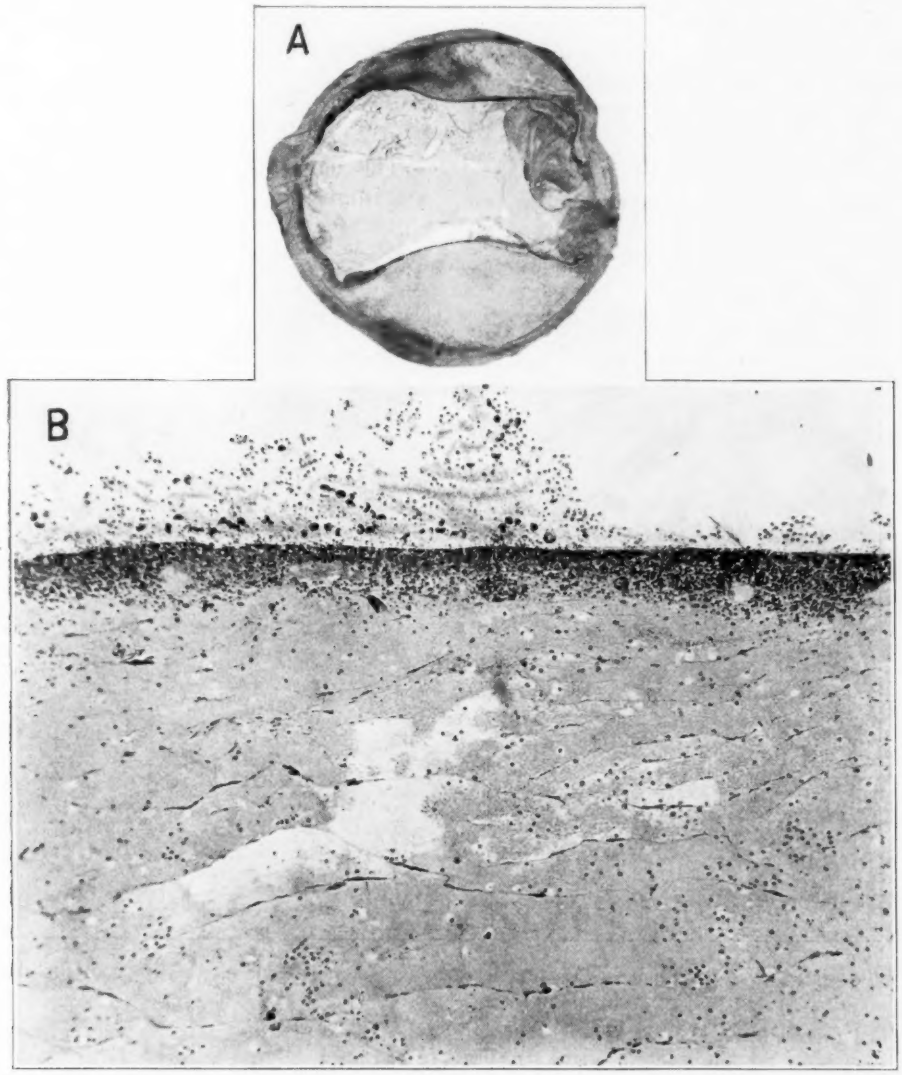

Fig. 11.—*A*, enucleation because of advancing suppurative uveitis following operation for secondary glaucoma. *B*, portion of the area of choroidal detachment.

of a subretinal clot and with permanent, fibrosed, elevated, cystic degeneration of the choroid and the retina. The patient completely recovered after operation. She has a permanent defect in the upper part of the field of vision and for three years has worn without change a correction for 6/22 vision with her aphakia spectacle lens.

The histologic sections now to be described are from cases in which an intraocular operation was performed and histopathologic study revealed a choroidal detachment.

Figure 8 shows minimal deep hydrops of the choroid with coagulated serous fluid from the perichoroid which followed surgical intervention for glaucoma. There is considerable elevation of the superficial lamellas of the choroid from the deeper layers anteriorly. The eye was enucleated because of postoperative suppurating keratitis. The splitting of the choroid is evident at the edge of the choroidal detachment. The eye was darkly pigmented, and because of this the splitting of the lamellas is more manifest. The choroidal vessels are engorged, with blood cells lying free in the choroidal stroma. The overlying retina was normal.

Figure 9 is a section taken after enucleation of the globe in a case of noncongestive glaucoma. The enucleation was done because of continued irritation following incarceration of the iris. (An iridencleisis had been done for glaucoma.) Preretinal hemorrhages lay free in the vitreous. A high degree of edema of the perichoroid extended to the ora serrata and beyond, into and beneath the ciliary body and continued posteriorly, past the equator of the eye. The choroid in places appeared normal. Cystic degeneration of the retina could be seen at the ora serrata. An area of retinal separation was also seen behind the ora serrata, with subretinal transudates. The appearance of the section suggests the possibility of traction on the choroid.

Figure 10 *A* shows small areas of discrete subretinal infiltration close to the papilla, accompanied by minimal amounts of choroiditis. The areas of choroiditis were slightly offset from the subretinal pathologic process. In *B* an area of choroidal detachment lies between the region of the retinal separation and the ora serrata. The perichoroidal lamellas, which are fragmented, are thickened and separated from each other by edema. The minimal subretinal pathologic change is present also in this section. Chronic vascular changes of the retina and of the choroid are absent.

CHOROID DETACHMENT OF INFLAMMATORY ORIGIN (CLASS THREE)

The next histologic sections to be described are from cases of uveitis in which a pathologic condition of the choroid was observed microscopically. They have only one factor in common, inflammation, of a rather severe degree.

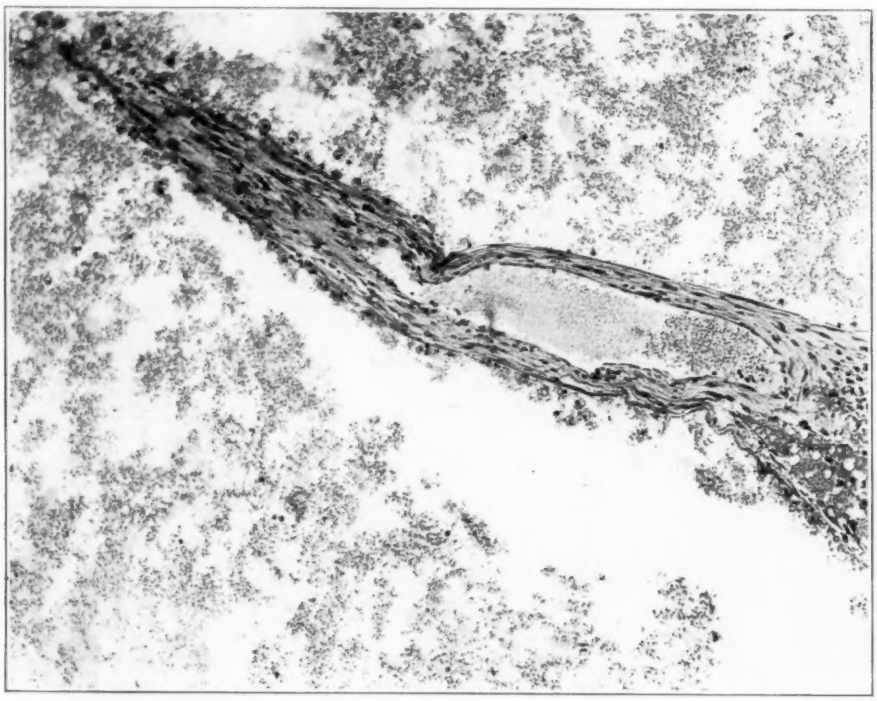

Fig. 12.—High power magnification of an area of old uveitis with massive hydrops of the choroid.

In only 1 case (fig. 11) had there been any surgical intervention, that apparently having been an operation for secondary glaucoma. The enucleation was done because of progressive suppurating anterior uveitis. The following figures demonstrate that inflammation is an important underlying factor in the causation of one type of choroidal detachment.

Figure 11 is from a case in which enucleation was done because of advancing suppurative uveitis following

operation for glaucoma. *A* shows massive edema of the choroid in the upper and the lower part of the globe, with gross infiltration and destruction of the retina and exudates and hemorrhages into the vitreous. The edema of the uvea is evident. *B*, a section from the center of

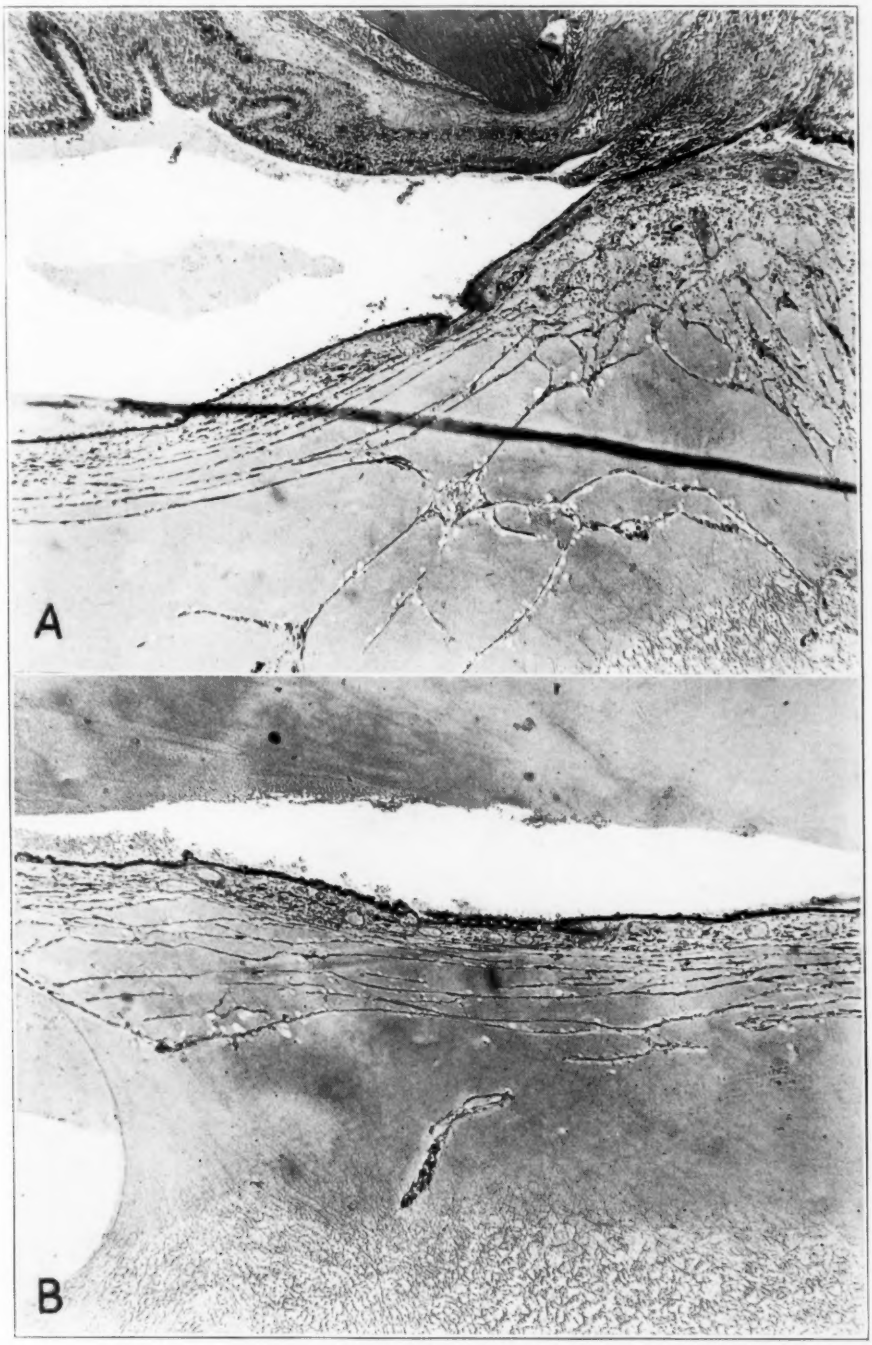

Fig. 13.—Detachment of the choroid due to traction.

one of the areas of hydrops of the choroid, shows separation of the lamellas, with massive edema of the lamellas themselves. Areas of cellular infiltration lie along the lamellas. High power magnification revealed many clusters of polymorphonuclear cells. There are separation, contraction and degeneration of the retina, with conspicuous subretinal exudates, infiltration and cellular debris. The exudate and hemorrhage into the vitreous are not shown, nor does the detachment shown include the sclera. There is little doubt that traction on the choroid may also have been a factor in this case. The total cross section of the area of choroidal edema with the magnification shown was about three times the width of the photomicrograph.

Figure 12, from a case of long-standing uveitis with conspicuous massive hydrops of the choroid, is a high power study of the granular structure of the intra-

lamellar transudate (perichoroidal), with engorgement and infiltration of a choroidal vessel. The choroid was separated from the sclera by a subchoroidal serofibrinous exudate. A true retinal separation was present, with a stained transudate lying between the choroid and the retina, although the fluid was of a somewhat different consistency than that seen in the choroid itself or between the choroid and the sclera.

In figure 13, from a case of uveitis, probably of long standing and undoubtedly of inflammatory origin, the anterior limits of the choroidal detachment are shown (*A*). There is massive edema of the perichoroidal lamellas, especially in the deeper portions. The sclera, which lay below the section, is not included. This section shows a high degree of severity of an old pathologic process of the retina, with conspicuous retinal

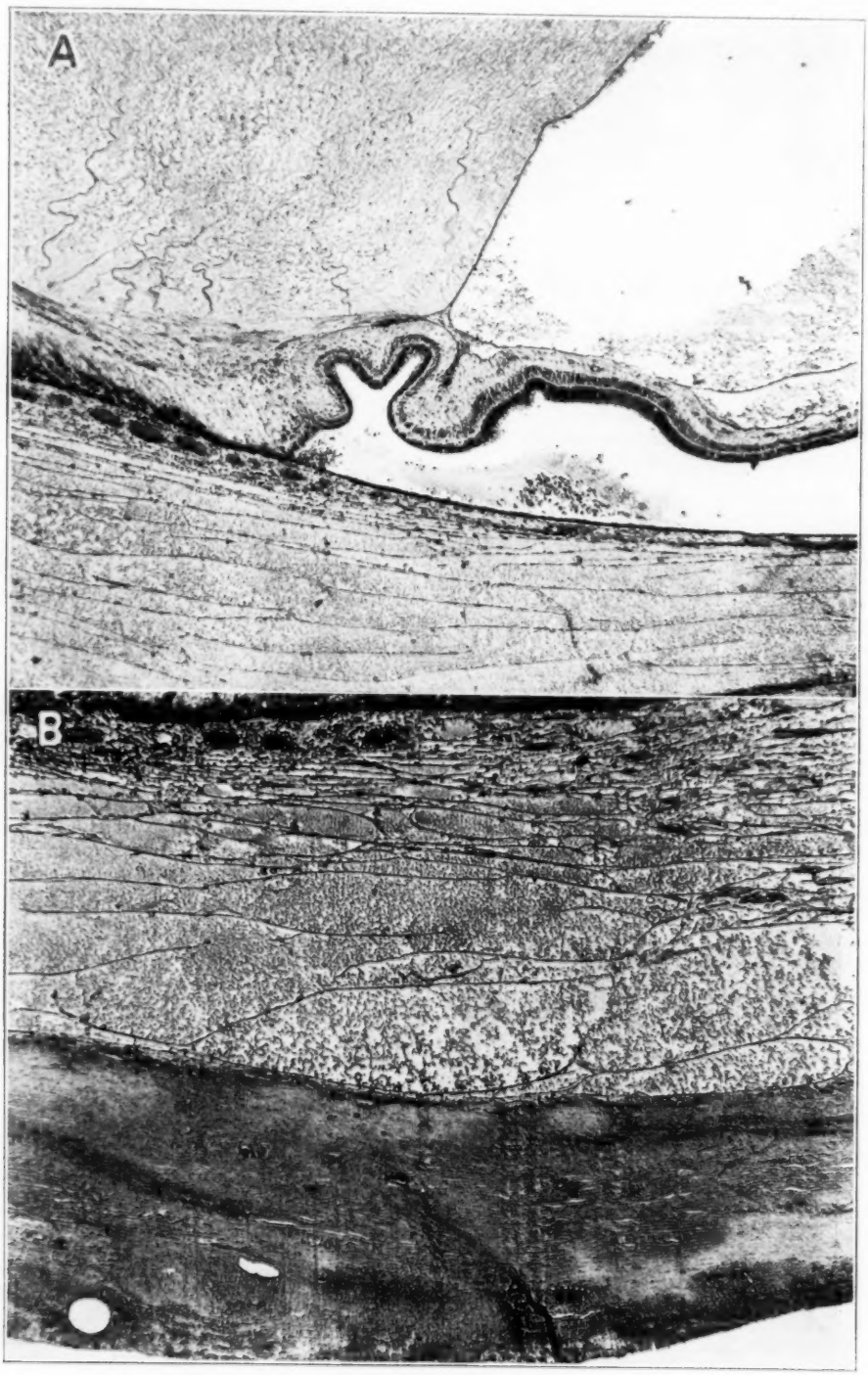

Fig. 14.—Generalized infiltration, with detachment of the choroid, the retina, the vitreous body and the anterior uveal tract.

separation. A portion of the degenerated, folded retina is included in the field. (Figures 13 and 14 are excellent illustrations of choroidal detachment due to traction.) Subretinal hemorrhage, transudate and exudate are all present. A subretinal transudate, overlying the choroid, is readily seen in *B*. This section was taken at the highest point of the choroidal detachment, although it does not include the total cross section of the area of choroidal edema. The sclera in this section also lay near the bottom of the photomicrograph. Subretinal transudate lies at the top of the section. The edema of the choroid is well seen, as well as the deeper serofibrinous transudate.

Figure 14 *A* is taken from a case of plastic iridocyclitis with generalized infiltration and detachment of the choroid, the retina, the vitreous body and the anterior uveal tract. *B* is a higher magnification of a portion of the same field, showing separation of the choroid by an area of massive edema lying near the anterior peripheral portion of the choroid and passing into the ciliary body. The condition was pure inflammatory choroiditis.

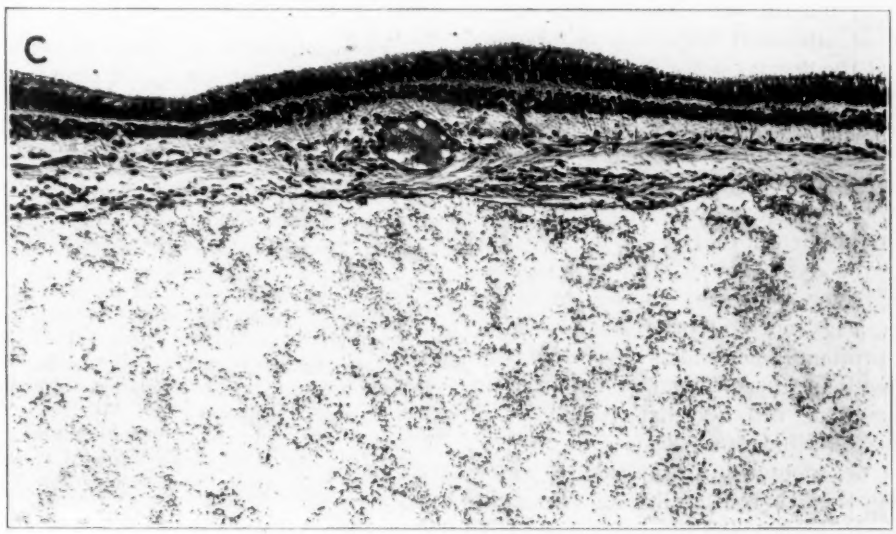

Fig. 14 *C*.—See legend on opposite page.

C is from another site at the posterior pole of the same eye, showing further choroidal and retinal inflammatory changes, somewhat dissimilar but certainly chronic.

The sections in these cases of choroidal lesions of inflammatory origin illustrate edema, cellular infiltration, perichoroidal detachment and fragmentation with the formation of a lamellated appearance, due, probably and primarily in most cases, to the effect of traction of a contracting uveal tract, with the establishment thereafter of a vicious cycle. It is probable that in these severe lesions the process could never be reversible. The infectious process itself and the intraocular presence of the products of this infection may be responsible alone, in many instances, for a choroidal detachment, without the necessity of the development of any type of uveal traction, though only in the cases of more recent acute inflammatory conditions.

SUMMARY AND CONCLUSIONS

On the basis of the clinical observations in the cases presented and, as a corollary, the study of the histologic sections, the following summary and conclusions are presented.

The term "choroidal detachment" is not essentially correct. So-called choroidal detachment may be due to massive edema of the choroid, a disturbance of the perichoroid or hemorrhagic choroiditis or a combination of the three conditions. It is doubtful whether an anatomic detachment of the choroid, that is, separation of the choroid from the sclera, occurs except as a result of trauma, either direct or postoperative, and then by dissection of the choroid from the sclera by a spreading, originally intrachoroidal, hemorrhage.

The term "massive perichoroidal edema" is a more correct designation for postoperative and post-traumtaic conditions not essentially hemorrhagic.

That so-called postoperative choroidal detachment lies anterior, rather than posterior, to the equator of the globe is the result of the anatomic distribution of the choroidal circulation.

Traumatic postoperative and post-traumatic hemorrhagic choroiditis, also called subchoroidal hemorrhage, are frequently accompanied by massive edema of the choroid, and the two are to be considered as not essentially dissimilar. The first form includes the catastrophic expulsive (so-called subchoroidal) hemorrhage which not rarely follows intraocular surgical procedures.

So-called choroidal detachment, including surgical trauma, may have as an intangible partial cause a preexisting inflammatory condition, such

as low grade uveitis or a degenerative vascular situation. This is suggested in the postoperative changes in the lens in certain cases in which so-called choroidal detachment had occurred after operation for glaucoma. The choroidal streaks which remain, in some instances permanently, do not eliminate this possibility, neither do they confirm it.

Hydrops of the choroid is a frequent accompaniment of long-standing uveitis, as is seen histologically. The condition, while not different histologically from that following intraocular operation, is certainly the result of the uveitis or of the hypotony or of both, the one being consequent on the other.

With serous detachment of the choroid and the ciliary body, it has long been considered [17] (1) that detachment is the natural complement of a considerable reduction in the intraocular pressure; (2) that its occurrence is the rule in every case of sustained reduction of pressure, and (3) that the degree of the detachment varies more or less as the degree of reduction of intraocular pressure. While these statements are basically concurred in, the subject is not to be dismissed so conclusively. Hypotony is present, and it may be the cause of a detachment. The development in the choroid of an inflammatory process, or the extension of a preexisting one, subacute in some instances, chronic in others, is, we think, a far more important factor. Many eyes with profound, permanent hypotony were examined without there being an apparent increased incidence in choroidal edema or in perichoroidal detachment.

In cases of spontaneous, immediate, serous hydrops of the choroid following operation transscleral diathermy and drainage can be of no avail, by reason of the anatomic changes in the choroid. The condition recedes spontaneously, without specific treatment. In cases of hemorrhagic choroidal detachment, immediate drainage through the sclera may be the means of saving the eye with useful vision. Choroidal detachment due to inflammatory changes is irreversible, and the prognosis is hopeless.

In the majority of instances immediate postoperative choroidal detachment should recede uneventfully with the closure of the operative wound or with closure of fistulas of choroidal or perichoroidal infiltration. Detachment appearing later after operation and detachment persisting beyond the time of closure of the wound frequently cause considerable concern and may result in permanent damage to the choroid. Choroidal detachment which appears, in rare instances, very late after operation (Verhoeff and Waite [18] and Elschnig [19]) may well be the result of an undiagnosed pathologic condition of the uvea. Traumatic hemorrhagic detachment of the choroid is the result of more extensive damage to the blood sinuses than is a serous detachment or one due to free rupture of a long posterior ciliary artery, or even of a vortex vein.

To quote Dr. Arnold Knapp,[20] in his differentiation of choroidal detachment as distinct conditions:

> . . . serous and hemorrhagic subchoroidal detachment is a different clinical syndrome from choroidal changes which are so frequently observed in enucleated eyes, in which the lesion seems to be due to hypotony or to inflammatory changes.

While we concur in this statement, we believe that, regardless of cause, the entire process, with the exception of traction of a diseased uveal tract (which is a late factor), arises from the blood vessels, in the form of edema, transudates and pure hemorrhage, the transudation being from the choroidal veins into the perichoroidal space. To quote Duke-Elder: [21]

> It is to be remembered that these veins, especially in the anterior region, are numerous and large, and are anatomically blood sinuses with a single endothelial wall. . . . A sudden release of external pressure will lead to engorgement, and transudation through their walls will be easy. Moreover, fluid withdrawn from beneath such a detachment is albuminous, containing fibrous, and some red corpuscles, and coagulates rapidly [O'Brien 1935]; it is therefore derived from the blood and not the aqueous.

It seems, therefore, that as the source of the fluids is the same—subchoroidal, choroidal and perichoroidal—regardless of the immediate (or late) etiologic factors responsible for the so-called detachment, the conditions are essentially similar pathologically, though differing in degree and in the end results.

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Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Cornea and Sclera

A NEW TYPE OF PIGMENT LINE IN THE CORNEA. F. W. STOCKER and R. E. PRINDLE, Am. J. Ophth. **27:** 341 (April) 1944.

Stocker and Prindle report a case of uveitis with a previously undescribed type of corneal pigment line. Eight months after the first examination there first appeared a fine line of brownish pigment, extending across the cornea from the limbus from 7 to 5 o'clock. A delicate branch with the same appearance radiated diagonally upward. The transverse line appeared to be a continuation of the limbal pigment onto the cornea. Biomicroscopic examination showed that the pigment line had a stippled appearance and was located in the most superficial layers of the cornea. Histologically, it lay within the epithelial cells of the cornea. Bowman's membrane was intact throughout, and both this membrane and the corneal stroma were free of pigment. The pigment did not take the iron stain and was considered to be melanin.

The article is illustrated. W. S. REESE.

TREATMENT OF HYPOPYON ULCERS WITH ALBUCID [SULFACETIMIDE] AND PROFLAVINE. P. D. TREVOR-ROPER, Brit. J Ophth. **28:** 181 (April) 1944.

Twelve patients with hypopyon ulcers were treated with sodium sulfacetimide, 12 with proflavine and 1 by oral administration of sulfapyridine (as the last substance had an untoward effect, it was not tried again). Three patients with hypopyon iritis were placed under a regimen of irrigations with proflavine, and all rapidly responded.

For all but 4 patients no pathogenic bacteria were obtained in culture of material from the conjunctival sac, and for these 4 patients further culture after use of the bactericide gave negative results.

In 3 of each series of 12 patients, usually those with very old lesions, a Saemisch section was required. Those in the proflavine series were all over 60 years of age, and 2 octogenarians of the series treated with sulfacetimide lost the eye. All the 18 remaining patients had a history of pain for only a few days; in all the patients treated with proflavine the hypopyon cleared rapidly, in an average of two days; but in 6 of those treated with sulfacetimide, the hypopyon cleared in an average of five and three-tenths days, and in the remaining 3 patients it was still present on their transference to a base hospital after three, twenty-one and forty-two days respectively. W. ZENTMAYER.

Experimental Pathology

A STUDY OF EPITHELIAL REGENERATION IN THE LIVING EYE. I. MANN, Brit. J. Ophth. **28:** 26 (Jan.) 1944.

Mann gives the following summary:

"Sliding or migration of healing epithelium has been demonstrated in the living eyes of rabbits possessing a pigment ring in the conjunctiva at the limbus, and also in Nigerians who show the same condition.

"The slide can be produced by simple trauma or by chemical injury. It is not so easily produced by heat.

"The shape of the slide is determined by the shape and position of the epithelial loss and can occur onto the conjunctiva or the cornea equally.

"The rate and shape of the slide do not appear to be influenced by the nature of the injury nor the condition of the underlying substantia propria.

"The sliding of a pigmented limbus after trauma can be distinguished from pigment proliferation after chemical stimuli and from pigment migration without epithelial loss in vitamin A deficiency." W. ZENTMAYER.

Injuries

THE VALUE OF OPHTHALMIC TREATMENT IN THE FIELD. G. C. DANSEY-BROWNING, Brit. J. Ophth. **28:** 87 (Feb.) 1944.

An analysis is made of 514 cases of ophthalmic injury from the Libyan campaign in which treatment was given at a mobile ophthalmic unit.

The types of wounds encountered and their treatment are outlined. In 14 of 67 cases of intraorbital foreign bodies treated the foreign body was extracted by the giant magnet at the base hospital. In only 1 case was extraction made in the forward area. In 22 cases the intraorbital foreign body had "perforated" the globe.

Owing to the terrain, about 200 men had to be operated on in the field unit.

It is suggested that "hospital infection" has been limited by local and oral administration of sulfonamide compounds, combined with a policy of "minimal interference" at the field medical units. No case of sympathetic ophthalmitis was reported in this series.

In 85 cases the wounds were of both eyes. In 45 cases the prognosis for the wounds of the two eyes was grave, and in 21 cases the men were subsequently reported as blind. Total disorganization of the globe occurred in 87 cases, and the eyes were removed at the mobile unit. In an

additional 27 cases the eyes were reported to have been removed at the base hospital.

It is submitted that by general comparison with the statistics for the first world war the results obtained for this campaign have not been adverse. W. ZENTMAYER.

WAR SURGERY OF THE EYE: AN ANALYSIS OF 102 CASES OF INTRA-OCULAR FOREIGN BODIES. H. B. STALLARD, Brit. J. Ophth. **28:** 105 (March) 1944.

The patients were treated at a general hospital during the period from the offensive of General Cunningham's Eighth Army in the western desert, in November 1941, to the end of the North African campaign, in May 1943.

In the analysis, the type of casualty, the nature of the missile, the site of penetration, the intra-ocular complications and the incidence of multiple wounds are noted. About 30 per cent of war missiles have low magnetic properties. When such a body is situated behind the lens, the posterior route of extraction through a scleral incision is the method of choice. The technic of this operation is described in detail.

Visual results and complications are discussed. The article is illustrated. W. ZENTMAYER.

A WASP STING. S. W. K. NORRIS, Brit. J. Ophth. **28:** 139 (March) 1944.

A lance corporal complained of epiphora, pain and photophobia of the right eye. He had been receiving treatment for "keratoconjunctivitis." Vertical striae, which stained with fluorescein, were present over the upper third of the cornea. A small papule with a brownish center was seen in the middle of the conjunctiva of the upper lid. A fine hair was removed from the center of the papule. This proved to be "the distal part of the lancet of the sting of a wasp." It was then learned that about seven weeks before the patient had been stung on the right eyelid by a wasp. W. ZENTMAYER.

Neurology

A CASE OF ADIE'S SYNDROME. T. JAMES, Brit. J. Ophth. **28:** 190 (April) 1944.

This pupillary anomaly was seen in a man aged 21, associated with absence of the right knee jerk, although a weak contraction of the quadriceps muscle could be detected, but only with reenforcement. The ankle jerk was absent on both sides. The superficial reflexes were normal. The triceps jerk on both sides and the knee jerk on the left side were normal. The Kahn test gave a negative reaction. The lens, fundus and tension were normal in both eyes. This case of Adie's syndrome did not present constantly all the features of the typical syndrome. At times the delayed "tonic" pupillary reaction was evident, and at other times it was not apparent or was doubtful. The consistently smaller size of the right pupil and its strong tendency to maintain a constant diameter seem at first to indicate a parasympathetic tonus of the sphincter pupillae; the fact, however, that complete dilation of the pupil did not follow mydriasis with atropine suggests the contrary, a hypotonic state of the dilator pupillae. It is reasonable, therefore, to assume (1) that the relative smallness of the pupil was due also to relative hypertonicity of the sphincter pupillae over the dilator or (2) that, since the actual size of the pupil remained moderate, there was an almost atonic nerve balance.

It is submitted, therefore, that the delayed "tonic" pupillary reflex of Adie's syndrome is in reality "atonic" and is due to generalized nervous asthenia, the degree of which may vary from time to time, with a corresponding effect on the pupillary reflex, which is much more sensitive to such variations than are the sluggish tendon reflexes. Kyrieleis Werner's procedure appears to support this conclusion.

The benign and nonsyphilitic nature of the syndrome in a young and healthy person, who is capable of leading a normal life, is confirmed, and its detection appears to be a matter of chance. Its recognition, however, should become established among insurance company physicians; otherwise, the likelihood is great that a prospective policy will be refused because of the absence of reflexes, with the usual implication. W. ZENTMAYER.

Ocular Muscles

RECESSION OF THE INFERIOR-OBLIQUE MUSCLE FROM THE EXTERNAL-RECTUS APPROACH. G. P. GUIBOR, Am. J. Ophth. **27:** 254 (March) 1944.

Guibor describes a method of recession of the inferior oblique muscle by first exposing and temporarily tenotomizing the external rectus muscle. The latter is then reattached or otherwise dealt with, as indicated. W. S. REESE.

Operations

TRANSSCLERAL LACRIMAL-CANALICULUS TRANSPLANTS. G. G. GIBSON, Am. J. Ophth. **27:** 258 (March) 1944.

This is a report on a series of experiments designed to lower tension by establishing an epithelial tube through the sclera. This work is still experimental and is not recommended as a clinical procedure, although one human eye was operated on with fair success. W. S. REESE.

A NOTE ON IRIDENCLEISIS. P. J. EVANS, Brit. J. Ophth. **27:** 548 (Dec.) 1943.

Iridencleisis, in common with all fistula operations, finds its best application in cases of non-

congestive glaucoma, either chronic or subacute. In cases of acute congestive glaucoma all manipulations of the iris or ciliary body are contraindicated if other procedures are possible.

Evans describes a modification of the operation of iridencleisis particularly applicable in cases of noncongestive glaucoma in which the iris is still elastic and the pupil still responsive to physostigmine. The scissors are applied, with the heel touching the globe and the points slightly raised; only about two thirds of the thickness (width) of the iris is cut, but the incision is carried to a sufficient length to provide a tongue which will easily reach the subconjunctival pouch through the lips of the incision. Replacement of the iris is effected by gentle external pressure over the corneal limbus and the temporal half of the wound, while a grip is retained on the tongue of the iris. By preference, the nasal pillar of the iris is included in the wound. Postoperative treatment consists of the use of massage and 0.5 per cent pilocarpine hydrochloride, with or without epinephrine.

W. ZENTMAYER.

Orbit, Eyeball and Accessory Sinuses

ORBITAL CELLULITIS IN A BABY CAUSED BY ACUTE OSTEOMYELITIS OF THE MAXILLA. J. A. MAGNUS, Brit. J. Ophth. **28:** 135 (March) 1944.

A girl aged 2 weeks had had a cold with nasal discharge. There was proptosis of the eyeball with edema of the lids. Within two days the clinical picture was that of orbital cellulitis. On the fifth day after admission to the hospital an incision was made through the medial part of the left lower lid down to the bone. A large subperiosteal abscess of the floor of the orbit was opened, and excessive pus was discharged from the opening. A small fistula persisted, and about three months later a sequestrum, measuring 8 by 10 mm., was removed by forceps. The fistula then closed, and further progress was uneventful.

The article is illustrated.

W. ZENTMAYER.

Refraction and Accommodation

A NOTE ON THE SPHERICAL EQUIVALENT OF SPHERO-CYLINDRICAL LENSES. W. J. RIDDLE, Brit. J. Ophth. **27:** 392 (July) 1943.

At a time when it is necessary to exercise simplicity in the prescription of glasses it may be of value to draw attention to a simple application of the principle of Sturms's conoid. The author cites Prangen's definition of the spherical equivalent of any formula for the correction of astigmatism as one equal to the value of the spherical lens plus half the value of the cylinder added algebraically. If the cylinder is reduced by any given amount, half of this should be added to the existing sphere. As the result of the war, the Council of British Ophthalmologists depre-

cates the prescribing of 0.125 D. powers. For example, if this were done, an error in refraction corrected by + 0.37 D. sph. ⊃ — 0.75 D. cyl., ax. 180 would have no lens prescribed.

W. ZENTMAYER.

Retina and Optic Nerve

COATS'S DISEASE. J. LAVAL, Am. J. Ophth. **27:** 163 (Feb.) 1944.

Laval concludes that Coats's disease and circinate retinopathy depend primarily on changes in the arterial system of the retina, whereas senile and juvenile macular degeneration are the result of changes in the choriocapillaris.

W. S. REESE.

A CASE OF EXUDATIVE AND HAEMORRHAGIC RETINITIS, WITH INCREASED INTRA-OCULAR TENSION, TREATED BY PILOCARPINE AND THYROID. A. LANDAU and J. RUSZKOWSKI, Brit. J. Ophth. **28:** 184 (April) 1944.

A married woman aged 40, after a blow above the right eye, had retinal hemorrhages and, subsequently, an operation for glaucoma. Two years later the eye was blind. The globe was later removed. In 1942 hemorrhages and exudates appeared in the retina of the left eye. Later, glaucoma occurred, and vision was reduced to counting fingers at 18 inches (45.7 cm.). Tension was controlled by use of pilocarpine. The cholesterol content of the blood was at the upper limit of normal, and the basal metabolic rate was — 10 per cent. In view of these findings, thyroid was given, and vision gradually improved to 6/18; fifteen months later the intraocular tension was maintained at a normal level, with use of pilocarpine.

W. ZENTMAYER.

Vision

LESS EVIDENT CAUSES OF LOWERED ACUITY IN SENILITY. R. I. LLOYD, Am. J. Ophth. **27:** 232 (March) 1944.

Lloyd discusses reduction of vision in older persons as caused mainly by corneal and macular disturbances and vascular accidents. He emphasizes the value of biomicroscopy and perimetry.

W. S. REESE.

Visual Tracts and Fields

THE PSYCHOGENIC COLOR FIELD. J. E. REEDER, JR., Am. J. Ophth. **27:** 358 (April) 1944.

In the neurasthenic patient there is a change in the way in which the colors are arranged and in the size of the field of colors. There is a notable decrease in the size of the form, as well as in the color. The fields are irregular in shape. The colors are interlaced, or they may be inverted. The colors may extend outside the form limits.

Reeder draws the following conclusions:

"It has been demonstrated that the psychogenic color field is of definite aid in the establishment of a psychoneurotic diagnosis. It is tangible evidence in an otherwise abstract diagnosis. It is a test that cannot be faked, therefore malingerers cannot make use of it. As in all things medical, no claim is made that this test is infallible, but when the test is positive it is an aid to diagnosis. In this series all of the psychoneurotic patients did have the change in the color fields, from mild to severe. Eighty-seven cases were reviewed; 72 were separated from the service for psychogenic reasons; 19 of the 72 were discovered by their psychogenic type of color field before they had had any association with the neuropsychiatrist." W. S. REESE.

Therapeutics

THE USE OF VASODILATORS IN ACUTE FUNDUS DISEASE. F. C. CORDES, Am. J. Ophth. **26:** 916 (Sept.) 1943.

Cordes cites cases of tobacco amblyopia, acute retrobulbar neuritis, optic neuritis, acute exudative choroiditis, chorioretinitis juxtapapillaris, acute closure of the central retinal artery, central angiospastic retinopathy and tuberculous choroiditis in which treatment was with the use of vasomotor dilators. The chief function of the therapy is to increase the supply of oxygen-containing blood to the anoxic capillaries and tissues.

If the lesion is of a serious nature, typhoid vaccine is injected intramuscularly in relatively small doses, followed as a rule by the subcutaneous injection of sodium nitrite. In the majority of cases sodium nitrite alone was used. The results were spectacular in most instances, owing in part to the fact that the patients were seen early and that they were in the relatively early age group. If the lesion has existed for a longer period, the prognosis is not good. Chronic lesions of the fundus in older patients who had considerable arteriosclerosis have not responded to vasodilator therapy. W. ZENTMAYER.

HYPERPYREXIA IN THE TREATMENT OF ACUTE OCULAR INFLAMMATIONS. H. C. KNIGHT, M. EMORY and N. CALLAHAN, Am. J. Ophth. **27:** 381 (April) 1944.

Knight, Emory and Callahan reached the following conclusions:

"The results of pyretotherapy in the treatment of inflammatory diseases of the eye are excellent in many cases, offering the only means of saving partial or total vision.

"The most striking immediate result of treatment is relief of pain. The restoration of vision is slightly more delayed, but very remarkable in most cases, depending on three factors: (*a*) the duration of the process before the start of fever therapy; (*b*) the number of treatments given while under the therapeutic regime; (*c*) the close coöperation of the ophthalmologist, first in persisting in the local treatment, and second in determining the point at which treatment is to be discontinued.

"It is evident that much vision may be saved by this method of therapy, and equally evident that it is not applied as much as possible even where it is available. It is desirable, therefore, that ophthalmologists become more aware of the usefulness of this therapeutic method, and ascertain the means at hand in their locality whereby they may make it rapidly available to selected patients." W. S. REESE.

Toxic Amblyopia

A STUDY OF THE HISTOPATHOLOGICAL CHANGES IN THE RETINA AND LATE CHANGES IN THE VISUAL FIELD IN ACUTE METHYL ALCOHOL POISONING. I. S. MCGREGOR, Brit. J. Ophth. **27:** 523 (Dec.) 1943.

In April 1942, 18 patients with poisoning from inbibition of methyl alcohol were treated in the Glasgow Western Infirmary. Seven were gravely ill and died in the hospital. The eyes of 4 of them, 3 women and 1 man, were secured for histologic study.

The author summarizes the histologic and clinical observations as follows:

The retina was examined in 4 cases with routine haemalum and eosin stains and by the method of examination in bulk after the tissue is stained with scarlet red and thereafter embedded and sectioned in gelatin. No changes in the ganglion cells of the retina could be attributed indubitably to acute methyl alcohol poisoning, either the lipid changes in the ganglion cells or the size and shape of the ganglion cells or the nuclear content.

The optic nerve in each case was examined in serial sections stained with hematoxylin and eosin, by Marchi's method and by a rapid staining method for myelin (Smith and Quigley), instead of by the Weigert-Pal technic. The optic nerves showed no abnormality. Four patients, who had been blind in the acute stage, were examined at the end of a year. One had no defect in vision; the second, a bilateral relative scotoma; the third, an absolute scotoma, with the other eye normal, and the fourth, a relative scotoma, with good vision in that eye and a normal fellow eye.

When death follows poisoning so soon, histologic evidences are few. The signs of acute poisoning are not sufficient to show whether the retinal tissue or the nerve tissue primarily succumbs. A review of the literature and the follow-up study of the cases described suggest that the poison acts on the center of the nerve.

W. ZENTMAYER.

Society Transactions

EDITED BY DR. W. L. BENEDICT

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

ALFRED COWAN, M.D., *Chairman*

WARREN S. REESE, M.D., *Secretary*

Nov. 18, 1943

Diabetic Cataract: Report of a Case. DR. GEORGE J. DUBLIN (by invitation).

Diabetic cataract is a distinct clinical entity. Rollo is to be credited with first speaking of cataract as a complication of diabetes. In general, this form of cataract may be of two types: The first is often observed in the adult in association with diabetes mellitus. It is similar in appearance to senile cataract, including the cuneiform, saucer-shaped and nuclear forms. Actually, there is no point of differentiation, and it is impossible to tell them apart by any known method of observation, even by slit lamp microscopy. In both senile cataract and the opacity of the lens in the adult associated with diabetes, microscopic examination with the slit lamp reveals vacuoles, fluid clefts and lamellar separation in the cortex, together with various opacities in the lens. Gradle in a series of 76 cases of diabetes noted changes in the lens in 41, with an average sugar content of the blood of 298.7 mg. per hundred cubic centimeters.

The second type of opacity of the lens, the true diabetic cataract, occurs in diabetic persons under 35 years of age. It has been considered a rare condition. O'Brien, Molsbery and Allen (Diabetic Cataract, *J. A. M. A.* **103:** 892 [Sept. 22] 1934) reported an incidence of diabetic cataract of 16 per cent in a series of patients under 35. In 1942 O'Brien and Allen (Ocular Changes in Young Diabetic Patients, *J. A. M. A.* **120:** 190 [Sept. 19] 1942) reported another series of 260 cases of diabetes in persons under 21 years of age in which they found 36 cataracts (an incidence of 13.6 per cent). True diabetic cataract may assume one of three forms, but all have the same characteristic in that the opacities are subcapsular, immediately adjacent to the subcapsular line. The most common type is the snowflake cataract of O'Brien, which is subcapsular, whitish, irregular in form and size and truly resembles snowflakes. In the second type the opacities are arranged as irregular, large and small plaques, together with fine, dustlike, dirty brown opacities, which are subcapsular and strongly resemble the cuneiform senile cataract. The third, or malignant, type is the bluish white opacity, in which the lens may become completely opaque and swollen in one to three weeks, "hydrops capsulae lentis." According to O'Brien and Allen, opacities of the lens in young diabetic patients occur invariably in persons whose diabetes has been poorly controlled or has been uncontrolled for several months. After stabilization of the diabetes, these opacities may progress slightly, but after six months of control they generally remain stationary.

The following case is presented.

REPORT OF CASE

Mrs. M. R., aged 22, white, was admitted to the metabolism department of Philadelphia General Hospital, in the service of Dr. Anthony Sindoni. The patient had had diabetes for ten years; a sore throat developed six days prior to admission.

Diagnosis.—The diagnosis was cervical adenitis and acute bronchitis. The chief finding of pertinence was the sugar level of the blood, which ranged from 245 mg., on the day of admission, to 356 mg. per hundred cubic centimeters.

She had been receiving 60 units of insulin for uncontrolled and unstabilized diabetes. Routine ophthalmic examination showed normal external structures with normal eyegrounds; in both lenses irregular, dirty brown opacities, occurring as large and small plaques, involved the anterior and the posterior subcapsular zone. Some of these opacities were pointed, resembling the cuneiform type of senile cataract. There was a small clear area of cortex between the opacity and the subcapsular line. The remaining portion of the lens was entirely clear. Vision was 6/60, Snellen scale, in each eye; with correction it was 6/12 in each eye.

DISCUSSION

DR. ALFRED COWAN: O'Brien and his associates divide what they call diabetic cataracts into two types. The type that Dr. Dublin reported resembles the senile disciform cataract. At first the opacity in the present case appeared to be just in front of the posterior capsule, but with the narrow slit beam it was seen to lie just behind the face of the adult nucleus, a narrow space being left behind the posterior capsule. The space was narrow because at the age of this patient, 22 years, the cortex is small. Usually opacities in the lens occur in the zone

of most recent development, but they lie deep, down to the last surface of discontinuity.

In the case reported by Dr. Dublin, the opacity was disciform, yellowish gray and similar in every respect to the ordinary senile type.

DR. JAMES S. SHIPMAN: I should like to come to Dr. Dublin's defense, if he needs it. In my limited experience diabetic cataract has been rare.

A patient under my observation for the past fifteen years has finally gone blind, not from cataract but from diabetic retinopathy, which was the first to appear in his case and was of gradual but definite progression. His blindness is due to the retinopathy, cataracts and superimposed secondary glaucoma. So diabetes takes its toll, and cataract is a complication, but whether it has a diabetic origin is hard for any one to say. I believe the criteria given by Dr. Dublin are as good as any—namely, the age of the patient, the history of diabetes in the presence of a high sugar content of the blood and the position of the opacities outside the embryonic nucleus.

DR. H. MAXWELL LANGDON: Dr. Dublin is accurate in saying that it is difficult to tell diabetic cataract from changes in the lens due to other causes. If a patient has cataract and a high sugar content of the blood with glycosuria, the cataract is usually said to be of diabetic origin, and probably it is; but I am doubtful whether the cause of the cataract is always the diabetes.

In many cases cataract in young people is unexplained. I have 2 cases in mind, the first, that of a woman aged 26, with bilateral cataract, whom I have had under observation for over five years. She has been completely studied at Jefferson Hospital, with special reference to metabolic tests; definite signs of hyperthyroidism were found, and the thyroid was operated on. I have thought that interference with the parathyroid glands may have caused the lenticular changes. There was no sign of diabetes. The cataracts are gradually advancing, the vision of one eye being reduced to 2/60, and operation will undoubtedly be necessary.

In the second case, a man aged 37 was visiting a patient of mine over the last fourth of July. After a slight accident, which had nothing to do with the eyes, he noticed that the vision of one eye was very defective. The following day I found that vision in this eye was limited to perception of light and that practically a mature cataract was present. The other eye was normal in all respects. He is a patient of Dr. Harry Gradle, in Chicago; Dr. Gradle examined him carefully one year ago and found nothing to indicate such a condition. If either of these patients had had diabetes, it would undoubtedly have been said that the cataract was of diabetic origin.

There are many elderly persons with ordinary senile changes in the lens who have an increase in the blood sugar and some sugar in the urine. Such cataracts are usually classified as diabetic, and they may be; but it seems to me that it is open to question whether a better designation would not be cataract in a person with diabetes.

In Dr. Dublin's present case, the cataract undoubtedly is due to the diabetic condition.

DR. I. S. TASSMAN: In line with what Dr. Langdon has just said, it seems that other factors are involved in the occurrence of cataract in diabetic patients. The sugar concentration of the blood at any one time in such patients is probably not the determining factor in the production of cataract. One sees diabetic patients with a high level of sugar in the blood and no cataract or retinopathy. In other patients with a comparatively low blood sugar level, one may find cataract alone or in association with retinopathy. These metabolic disturbances do not affect all patients in the same way. When cataract develops in a young person with diabetes, it should be called diabetic cataract, but there are certain unknown factors present, in addition to the sugar concentration of the blood, which are probably causative in the production of the ocular condition.

DR. SOLOMON S. BRAV: About two years ago my son, Lieutenant S. Brav, presented the case of a child, about 14 years of age, with diabetes. There was no pathologic process of the retina or diabetic retinopathy, but vision was reduced to about 2/200. The child was in school during the early course of the illness but could not make any progress; the question at the time was whether or not the ocular condition was congenital or diabetic. I think my son decided the cataract was of diabetic type. Personally, I could not differentiate between one form and the other.

I operated on both eyes about a year ago, with resulting vision of 20/30 in each eye. The child, now about 16 years old, is doing well; the diabetes is still present, but there is no retinopathy.

DR. GEORGE J. DUBLIN: Differentiation of diabetic and congenital cataract in the young person should not present a great problem. The various layers of the lens develop at certain periods of life, and congenital opacities of these layers have a typical location and appearance. For instance, if a congenital opacity is limited to the embryonic layer, the opacity formed sometime during the first three months of uterine life. If the opacity is in the fetal nucleus, it occurred between the third and the eighth month of fetal life, and if it is in the infantile nucleus, it probably appeared during the first month after birth. The adult nucleus develops at about the age of 10 years or later, and an opacity of the corre-

sponding zone indicates involvement at the age of puberty.

Congenital cataract, unless it is completely opaque, with obliteration of all layers of the lens, is comparatively easy to diagnose. A history of diabetes, with rapid onset, would be of great help in differentiation. It was previously mentioned that there is a malignant type of diabetic cataract called "hydrops capsulae lentis," a bluish white cataract, with pronounced edema. This, in my opinion, is the only type which may be confused with total congenital cataract. The other types of diabetic cataract progress slowly and do not mature within several weeks, as some authors have stated.

The diabetic cataract in the case presented here is about one year old. Examination of the eyes two years ago failed to reveal any opacity of the lens. O'Brien and Allen claimed that when diabetes has not been stabilized cataract is likely to develop. O'Brien stated that if six months or more elapses without good control, with poor control or without any control of the diabetes, the opacity is likely to develop; he further claimed that if the disease is under complete control or has been stabilized for approximately six months, the cataract rarely develops further. After the cataract reaches a certain stage, it remains stationary.

Diabetic cataract is similar to, and may be confused with, cataract associated with other endocrine disturbances, such as parathyroid disorders and tetany. In cataract associated with tetany the location is similar, the opacities being in the deep portion of the cortex, but frequently they are blue and green. Other glandular disturbances producing cataract are cretinism, myotonia atrophica and mongolism. The opacities associated with all these conditions are similar in location and appearance, and without a history and physical examination they are extremely difficult to differentiate from diabetic cataract.

Epidemic Keratoconjunctivitis. DR. H. MAXWELL LANGDON, DR. VAN M. ELLIS and DR. ROBERT D. MULBERGER.

Epidemic keratoconjunctivitis, first described by Hogan and Crawford (*Am. J. Ophth.* **25:** 1059 [Sept.] 1942), is characterized by congestion and swelling of the conjunctiva and lids; at times a false membrane, more likely to be on the conjunctiva of the lower lid; frequent enlargement of the preauricular lymph glands, and round or ovoid dots on the cornea just below Bowman's membrane, which are highly refractile and may break down and show slight staining.

The disease in cases occurring in the eastern part of the country has not differed from this description. At times the cornea breaks down and takes a slight stain. In our experience, the course of the condition is irregular, and there is no specific treatment, although we have not tried injection with convalescent blood. Many of our patients had a preexistent slight injury or inflammation of the eye a week to two weeks previously. Cultures show indifferent growth, usually diphtheroids or Staphylococcus albus.

Murray Sanders (Epidemic Keratoconjunctivitis ["Shipyard Conjunctivitis"]: I. Isolation of a Virus, ARCH. OPHTH. **28:** 581 [Oct.] 1942), reported the isolation of a virus which produced encephalitis in mice and, after injection into a healthy man, who acted as a volunteer, produced conjunctivitis, although the author did not mention corneal complications.

The corneal dots may entirely disappear or may leave faint gray areas behind them. All our patients had complete recovery of vision to normal or better, although in 1 patient it was reduced to as low as 5/30 during the acute phase. In none of our patients could we trace any definite connection with an infected patient. We regard the corneal dots as the most definite diagnostic sign.

Our treatment consisted mainly of use of boric acid and phenacaine hydrochloride for relief of the discomfort; ice compresses for the swelling; tannic acid or silver nitrate for the catarrh of the conjunctiva, and, in the later stages, boric acid ointment U. S. P. for massage, which we feel aided in the clearing of the cornea.

We had 45 patients with corneal complications—31 males and 14 females; both eyes were involved in 7 patients, the right eye in 23 patients and the left eye in 15 patients.

In some of our cases of most severe involvement the disease was binocular, which makes us feel that these patients were particularly susceptible. We have had about 25 other patients with what we feel was the conjunctival form of the disease, but they did not have corneal complications.

DR. EDMUND B. SPAETH: Dr. Alson E. Braley, in Chicago at the recent meeting of the American Academy of Ophthalmology and Otolaryngology, presented an analysis of some 300 cases of this form of keratoconjunctivitis. He emphasized something which neither Dr. Langdon nor I had seen before, i. e., recurrence; when patients with this disease recover they usually remain well. Also, their symptoms may disappear while they still have clinical signs of disease of the infiltrated cornea. For that reason, the case of the young woman which I shall present here is interesting.

The patient consulted me ten weeks ago with severe unilateral keratoconjunctivitis of the epidemic type. The condition was so severe that she had to be hospitalized. Ten days later she was out of the hospital, and ten days afterward she was back at work. Six weeks later she returned, with the lids of the right eye swollen, due to edema, and with lacrimation. photophobia and a sticky discharge. This was

not a recurrence because she had not recovered, though she had apparently recovered clinically; now, six weeks later, she has almost as severe symptoms as she had at the first attack.

With regard to treatment, and I speak personally, because I had the condition, Dr. Langdon's statements about therapy are correct. The best treatment for the disease is early application of cold compresses to the eye, and later heat, a bit of epinephrine and enough pentacaine to keep the patient comfortable. Sulfathiazole was of no value whatever. As a matter of fact, it seems to irritate the eye. The therapy in my own case was suggested to Dr. Shipman and me by another physician, Dr. Kennedy, who had had the condition earlier, and who had gone through the same useless round of therapy. It is now known that specific serum, if administered early in the condition, relieves the symptoms to a notable degree and apparently shortens the course of the disease.

Dr. A. G. Fewell: During the epidemic of keratoconjunctivitis this spring I saw about 12 cases. My experience was the same as that of Dr. Langdon in that no 2 cases were in the same family. My cases were from all sections, some from outside the state, and in all the glands were involved.

None of my patients had mucopurulent discharge, although there was considerable tearing, with some ropy secretion. The majority of my patients had bilateral involvement and all but 1 had some infiltration of the cornea. The patient who had no involvement of the cornea was the only one who was given convalescent serum, and the infiltration cleared up in a week. The other patients were treated with pentacaine and epinephrine, and with a few I tried a sulfonamide compound, but none of these measures seemed to shorten the course of the disease. The majority of the corneal lesions were treated with Pregl's solution (containing the sodium salts of hydriodic acid and iodic acid with iodine [0.04 per cent]), which seemed to help the opacities clear a little more rapidly than those for which it was not used. In most of my cases the condition lasted from four to five weeks.

Dr. Aaron S. Bray: I have seen many patients with this disease. Most patients have chemosis, and a notable symptom is severe burning of the eye. I have not seen any patients with mucopurulent discharge. I have seen 2 patients with what looked like a pronounced membrane on the lower lid. Physicians say that they have never seen a distribution of the infection in a family. On the contrary, I have 6 patients in one family, and I am still treating them. A grandmother and child were in my office yesterday.

As for the mucopurulent discharge, I should say that was due to a mixed infection. As for the transmission of the disease, 1 of my patients complained to her physician that she was sure she got the infection in my office. She had consulted me for refraction, and about two weeks later the severe burning sensation appeared. There were several patients with the conjunctivitis in my office at that time. In St. Louis they think that the mode of transmission is through the physician's office.

I am not as lucky as Dr. Langdon. In my cases the corneal opacities did not clear completely. In fact, my daughter has had the disease nearly three months and still has numerous, probably ten to fifteen, centrally located opacities in the cornea, and her vision is reduced to 20/30 +.

As to treatment, I have had the same discouraging results.

Dr. Irving L. Pavlo: At Wills Hospital we residents have seen several hundred patients with this condition during the past year. A number of factors indicate that it is infectious. Several waves of infection have occurred among clinic patients with glaucoma who had determinations of tension at short intervals with the same tonometer, which must have been insufficiently sterilized. Also, in the wards for patients with cataract, there have been several severe waves of infection, twice necessitating a quarantine of those wards. Most of the epidemiologic evidence points to an incubation period of eight to eleven days, more often the latter. This was shortened in the case of patients infected after cataract extractions, many of whom showed the fully developed disease by the time of the second or third postoperative dressing. It is interesting to note that none of these patients had any intraocular complications. The wife of one of the three resident surgeons who were victims of the condition had the disease after a clearcut incubation period of ten days.

Dr. Alfred Cowan: The incidence of epidemic keratoconjunctivitis among ophthalmologists is rather high. I have seen 3 well known ophthalmologists with the disease.

Dr. H. Maxwell Langdon: As for patients getting it at the physician's office, most of our patients picked it up on their own account. Boric acid ointment massaged daily on the eye, with a little placed under the lid, clears the opacities of the cornea better than anything else that we have tried.

External Ophthalmoplegia. Dr. Van M. Ellis.

A Negro girl was first seen at the Presbyterian Hospital clinic at the age of 1½ years, at which time the mother stated that both eyelids had been drooping for the past two weeks. She has been under observation in the clinic up to the present.

The condition at present is as follows:

Vision is 6/30 in the right eye and 6/12 in the left eye with correction. The pupils are

equal and react to light and in accommodation. The patient has ptosis and complete palsies of the third, fourth and sixth nerves; the eyes are immobile, the right eye diverging about 20 degrees. The internal structures of both eyes are normal.

The child has been studied in the pediatric, neurologic, orthopedic, rhinolaryngologic and dental clinics. The neurologic condition, except for the ocular condition already described, is normal. The pediatricians consulted suggested that the child's ocular condition was the result of congenital syphilis; however, repeated Wassermann tests have all given negative reactions. Palpable epitrochlear glands are present. There is, however, a family history of syphilis, inasmuch as the mother and the younger sister are now under treatment at the Graduate Hospital.

Myasthenia gravis has been ruled out by therapeutic tests with physostigmine and electrical reaction tests. The rhinolaryngologic examination gave negative results. Roentgenographic examination of the skull and the sinuses revealed nothing unusual. All laboratory examinations, including studies of the spinal fluid, gave normal results.

Hence, the case is one of external ophthalmoplegia, the cause of which at present is undetermined.

DR. GEORGE F. J. KELLY: Did Dr. Ellis say this condition started a year and a half ago?

DR. VAN M. ELLIS: At the age of 1½ years.

DR. GEORGE F. J. KELLY: It is not likely that the condition is congenital ophthalmoplegia if it came on at the age of 1½ years.

Exudative Choroiditis. DR. I. L. PAVLO (by invitation).

A man aged 26 entered Dr. Fry's ward service at Wills Hospital on Nov. 3, 1943 with vision in the right eye of ¼/60. The loss of vision had occurred three weeks previously, or ten weeks after onset of an atypical pneumonia, which had left a residuum of hoarseness and persistent cough, with much tenacious, nonfoul, mucopurulent, blood-tinged sputum. Visual difficulties began after a night of severe coughing.

Examination of the right eye showed small gray keratitic precipitates; aqueous flare; mydriasis; clear lens; slight haziness of the vitreous; a light yellow-gray area of exudate, measuring 2.5 disk diameters, over the macula and disk, elevation of the disk of 2 D., with small hemorrhages, dilatation of veins and perivasculitis.

The visual field for 10/1,000 showed a cecocentral scotoma, measuring 34 by 43 cm. The left eye was entirely normal, with 6/6 vision.

Two carious teeth were extracted. Drainage of a maxillary sinus, which was acutely infected, yielded frank pus, which, unfortunately, was not examined bacteriologically. Ten days later the sinuses were clear.

There were rales at the base of the left lung. A roentgenogram showed homogeneous haziness over the lower lobe of the left lung, with faint mottling; this was thought not to be tuberculous. The heart and blood pressure were normal. The possibility was considered that the pulmonary condition was typical chronic pneumonia due to Bacillus Friedländer. B. Friedländer was observed in pure culture in the sputum, which contained no acid-fast organisms. Successive cultures of specimens of the sputum yielded mixed growth, with progressively fewer Friedländer bacilli; typing was not done. Smears of prostatic secretion contained no gram-negative diplococci. Urinalysis, serologic studies, determinations of the blood sugar and sedimentation time and agglutination tests for brucellosis revealed nothing abnormal. Studies of the blood gave normal results except for leukopenia, the white cell count being 4,500 per cubic millimeter. Intracutaneous injection of 0.0002 mg. of purified protein derivative produced a 2 plus reaction for tuberculin.

The patient had a subfebrile temperature, which gradually fell to a normal level. His cough slowly cleared. The exudative choroiditis showed progression in extent and severity, at one point suggesting early proliferative retinitis.

The morphologic, cultural, manifold pathologic and serologic properties of the Friedländer bacillus, or Bacillus mucosus capsulatus, are discussed. The unusual, chronic type of pneumonia caused by this organism is consistent with the clinical picture presented by the patient. Persons in the younger age groups have a definite resistance to the organism.

Investigation of the pathogenesis of uveitis rarely gives evidence susceptible of scientific proof, as attested to by Berens and associates in their negative cultures of the blood, aqueous and pharyngeal secretions for the causative organism in 91 patients with this disease. Morphologic or cultural proof of actual invasion of the uvea by an organism is rare, as is evidence of direct irritation by bacterial endotoxins or exotoxins. Hypersensitivity to allergins produced by bacterial foci rests chiefly on evidence of a clinical nature and admits of wide divergence of opinion as to the relative importance of pyogenic foci and of tuberculosis and syphilis.

In summary, this patient with exudative choroiditis presented an unusual variety of possible etiologic factors, including pulmonary infection due to Friedländer's bacillus.

DR. W. E. FRY: My associates and I examined carefully every patient with acute "exudative choroiditis" at the hospital, and it has been our experience, and probably that of others, that in a number of cases we do not find, or are not sure of, the cause of the ocular difficulty. Dr. Pavlo's case illustrates just the reverse situation. So many causes are suggested that one can take one's pick.

This patient will present an interesting problem. If one should examine him several months from now, at which time his pulmonary condition will probably have entirely cleared and any other focus of infection secondary to the pulmonary condition have disappeared, and should find a positive tuberculin reaction, one might conclude that the patient had tuberculous choroiditis, whereas the present evidence suggests that the real cause is a pulmonary complication.

Epibulbar Tumor: Report of a Case. DR. W. E. FRY.

A woman, in April 1915, at the age of 34, first noted a small pigmented lesion at the limbus of her left eye, at 1 o'clock. In October 1916 the lesion measured 4.5 by 2.5 mm. and extended 1.5 mm. into the cornea. The patient was first under the observation of Dr. Holloway and more recently under my care; April 1941 the eye was enucleated. The patient is at present alive and well. The nodule was excised in January 1920, and the pathologic diagnosis, made by Dr. Case, was that of melanosarcoma. A nodule was excised a second time, and three applications of the thermophore were given. The lesion recurred locally and traveled about the limbus in a counterclockwise direction. There has been no evidence of metastasis.

Pathologic Report of the Enucleated Eye.—Section of the eye revealed a deeply pigmented tumor near the periphery of the cornea. The mass in the section measured 3 mm. It was composed of pigmented, elongated and spindle cells. The nuclei were deeply stained and varied moderately in size. The associated inflammatory reaction was evidenced by clusters of polymorphonuclear cells. The mass was entirely superficial to Bowman's membrane. The tumor was partly divided by a band of dense connective tissue. All the superficial portion of the cornea was involved by tumor cells to a varied degree. These were seen at places within, as well as below, the epithelium and beneath superficial bands of connective tissue. A band of partly hyalinized connective tissue spread across the cornea above Bowman's membrane. Bowman's membrane was unbroken, and the stroma beneath the membrane appeared normal.

The remaining portions of the eye were uninvolved except for an unusual number of pigment granules in the corneoscleral trabeculae.

Conclusion.—Certain portions of this report may be emphasized: The patient has been under observation twenty-eight years. The tumor was of a type usually considered highly malignant—melanosarcoma. In spite of recurrences, the final pathologic examination revealed that the corneal involvement was entirely superficial. There has been no distant metastasis—if there had been, the patient would have died years ago. The tumor apparently possessed only the property of local recurrence.

An additional point of interest is that, although microscopically the cornea appeared remarkably clear, visual acuity was less than 6/60. This is of importance in the correlation of experimental corneal disease and the effective result of treatment.

DR. JAMES S. SHIPMAN: Why was radium not employed in this case, and what might have been the result if it had been used? In most of the cases at Wills Hospital, Dr. Widmann advises irradiation before excision, and my associates and I have followed that policy routinely with epibulbar growths. After excision, a correct diagnosis can be made, and further irradiation can be carried out if indicated.

Dr. Fry stated that Colonel Ash expressed the belief that irradiation was unnecessary for carcinoma. Why is that true, and does the same thing hold for melanosarcoma?

DR. W. E. FRY: This patient was seen on at least one occasion, perhaps on several, at the roentgenographic department of the university, and irradiation was advised against.

Dr. Shipman is in agreement with some persons with regard to irradiation. For instance, Dr. Reese, in a recent discussion of the treatment of precancerous melanosis of the conjunctiva (*Tr. Am. Acad. Ophth.* **47**:420 [May-June] 1943), recommended excision and irradiation by application of radon directly to the site of the growth.

Correspondence

VERNAL CONJUNCTIVITIS

To the Editor:—In a letter published in the June issue (ARCH. OPHTH. **31:** 557, 1944), Dr. Louis Lehrfeld, of Philadelphia, severely criticizes my article entitled "Ariboflavinosis as a Probable Cause of Vernal Conjunctivitis," which appeared in the March issue (ARCH. OPHTH. **31:** 214, 1944). I am making the following comments, not for the purpose of starting a fruitless discussion, but in the hope that they may clarify some of the points brought out in Dr. Lehrfeld's letter.

First, I wish to point out to Dr. Lehrfeld that my theory neither attacks nor excludes the theory that in certain cases vernal conjunctivitis may be an ocular manifestation of an allergic state. However, it would be difficult to prove that every case of this disease has an allergic condition as its only cause. In my article, I merely suggested that ariboflavinosis may be one, not necessarily the only, cause of vernal conjunctivitis.

Dr. Lehrfeld states that he disagrees with my theory, which "lacks scientific confirmation." This is necessarily true, as sufficient time has not elapsed to allow other authors to prove or disprove it; in the latter case I should be the first to admit the facts. He also expresses surprise that I did not mention vernal conjunctivitis as an ocular manifestation of an allergic state, and he continues by citing facts in support of the allergic theory. Later, he states that the description I gave of the disease differs from descriptions he had already published (Lehrfeld, L.: Observations on Eighty-Seven Cases at the Wills Hospital, ARCH. OPHTH. **8:**389 [Sept.] 1932. Lehrfeld, L., and Miller, J.: Additional Research on Vernal Conjunctivitis, ibid. **21:** 639 [April] 1939).

On the first page of my article, second column, line 17, I stated: "Other authors have attributed it to various conditions such as hay fever and anaphylaxis; generally the cause is stated to be unknown." I did not consider it necessary to enter into more detail concerning all the etiologic theories of vernal conjunctivitis or to give a more elaborate description of the illness, as my primary purpose was to set forth the theory of the role of riboflavin deficiency on the basis of the results obtained with this vitamin, leaving to others more capable than I the minute pathologic description of the disease.

It appears that not all authors admit allergy as the cause of vernal conjunctivitis and the following authors do not even mention it: Fuchs (Tratado de oftalmología, Barcelona, Editorial Labor S. A., 1936, p. 206); Berens (The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, pp. 404-407); May (Manuel des maladies de l'œil, Paris, Masson & Cie, 1936, p. 162), and Römer (Tratado de oftalmología, Barcelona, Manuel Marín, Editor, 1932, p. 162). Other authors have stated the belief that allergy does not explain all cases of the disease. Gifford (A Hand-Book of Ocular Therapeutics, ed. 3, Philadelphia, Lea & Febiger, 1942, pp. 238-240), citing Lemoine, stated this opinion. Ridley and Sorsby (Modern Trends in Ophthalmology, London, Butterworth & Co., Inc., 1940, p. 9) asserted: "Nevertheless, in the present state of our knowledge, the allergic basis of vernal conjunctivitis cannot be fully conceded." In light of these assertions, it is difficult to understand Dr. Lehrfeld's lament that the ARCHIVES have given "conspicuous space to an article purporting to refute a recognized fact." As the chief editor accepted my manuscript, he apparently considered it worthy of publication, and it is precisely to the selection of its articles that the ARCHIVES owes its unquestioned prestige.

Dr. Lehrfeld is right in saying that there are certain differences in vernal conjunctivitis in different regions. In the part of northern Mexico from which I wrote, the disease is seldom encountered in its most severe form, and in general it is characterized by the subjective symptoms of itching, sensation of heat or of a foreign body (such as dust) in the eyes and mild photophobia. The objective changes are presented in the tarsal conjunctiva and in the sclerocorneal limbus and its vicinity, while the rest of the bulbar conjunctiva and the fornix are normal. On the other hand, in Hawaii, where the thermometer never goes lower than about 60 F. in the wintertime, the problem of treating vernal catarrh is an annoying and difficult one. There the disease occurs in its severest and most exaggerated form, and often the under surface of the upper lid is filled with hard, "cobble-stone" masses, which continually keep the eye irritated (Dr. G. M. Van Poole, in a personal comunication).

Unfortunately, in Mexico, there are lacking the support and organization necessary to maintain hospitals and research institutions with facilities which permit the carrying out of a well documented scientific investigation; for this reason, I have been unable to obtain any data on the amount of riboflavin in the urine of my patients. As I said before, my theory is based only on the results obtained by treatment with

riboflavin of patients with vernal conjunctivitis, and I leave to others its scientific confirmation.

Finally, quoting from the bulletin of the National Research Council, Dr. Lehrfeld states that recession of the lesions of chronic ariboflavinosis is very slow, and he concludes by pointing out to the readers of the ARCHIVES that relief of ariboflavinosis is not as prompt as I have reported in patients with vernal conjunctivitis. For my part, I wish to note that the bulletin does not mention the severity of the chronic ariboflavinosis to which it refers, and that there is a great deal of difference between a slight and a severe lack of riboflavin, relief of the second deficiency being slower than that of the first. Conners, Eckardt and Johnson (Riboflavin for Rosacea Keratitis, Marginal Corneal Ulcers and Corneal Infiltrates, ARCH. OPHTH. **29**: 956 [June] 1943) stated:

> After three or four daily intravenous injections of riboflavin, these infiltrates and the capillaries disappear, with relief of symptoms, even though a coexisting blepharoconjunctivitis remains unchanged clinically. . . . In the latter two conditions [rosacea keratitis and catarrhal ulcers], riboflavin simply reduces the duration of symptoms from one or two weeks to one or two days.

I wish to thank Dr. Louis Lehrfeld for the interest he has taken in opposing my theory; it proves to me that in the scientific world there are men who defend not a theory but their own infallibility.

LUIS CASTELLANOS A., M.D.
Aldama 112, Chihuahua, Mexico.

News and Notes

GENERAL NEWS

Research Study Club of Los Angeles.—The Research Study Club of Los Angeles announces its fourteenth annual midwinter postgraduate clinical convention in ophthalmology and otolaryngology, to be held from Jan. 22 to Feb. 2, 1945. A special course in "Applied Anatomy and Cadaver Surgery of the Head and Neck" will be given February 2, 3, 4, 5 and 6 inclusive. Instructors and lecturers include C. S. O'Brien, M.D., Iowa City; Kenneth Swan, M.D., Portland, Ore.; William Crisp, M.D., Denver; John Shea, M.D., Memphis, Tenn.; Hans Brunner, M.D., Chicago; Guy Lee Boyden, M.D., Portland, Ore.; Chauncey D. Leake, M.D., Galveston, Texas; Verne O. Knudsen, Ph.D., Los Angeles, and Scott Reger, Ph.D., Iowa City. Applicants for the course should write to Pierre Viole, M.D., 1930 Wilshire Boulevard, Los Angeles 5, Calif.

Collection of Historic Tonometers.—The tonometer checking station at the Illinois Eye and Ear Infirmary is making a collection of historic tonometers. Will any reader who has a tonometer of interest for this collection donate it for display? Credit will be shown. Any descriptive letters of such tonometers will be appreciated. Address: Dr. Harry S. Gradle, 58 East Washington Street, Chicago.
appreciated.

Course on Extraocular Muscles.—Dr. James W. White, of New York, will give a course on the extraocular muscles, with demonstrations, Dec. 9 to 16, 1944, inclusive, at Northwestern University Medical School, 303 East Chicago Avenue, Chicago.

For further information, address: Dr. B. Cushman, 25 East Washington Street, Chicago.

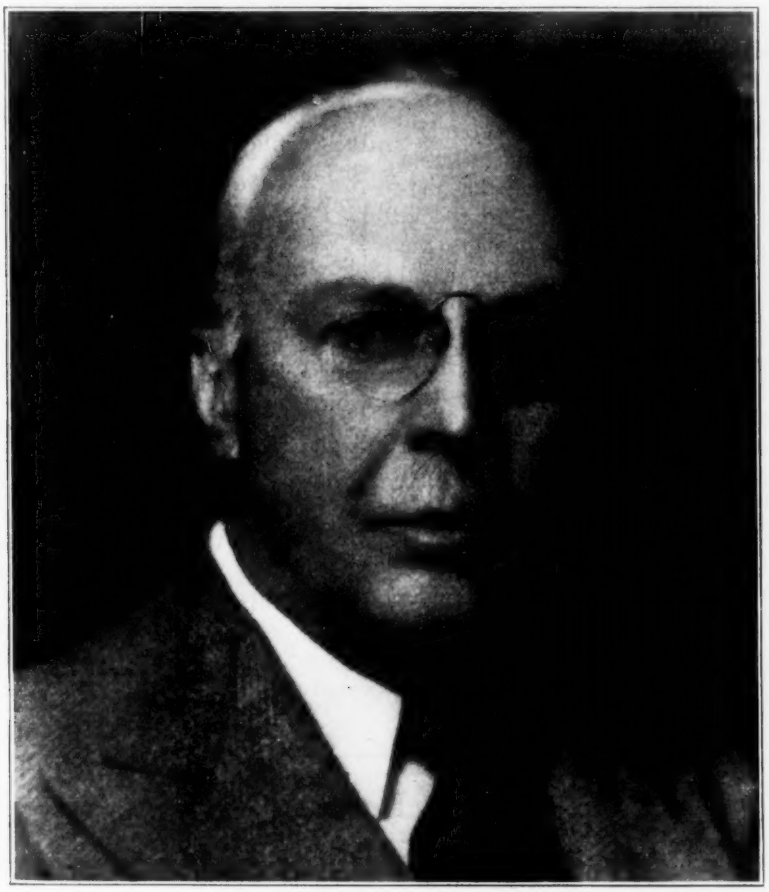
SOCIETY NEWS

Ophthalmological Society of Egypt.—To encourage scientific ophthalmic work the Ophthalmological Society of Egypt will award a gold medal with a value of 20 Egyptian pounds for the most valuable contribution of the year. The competition is open to all members of the society who have practiced less than twenty years, whether staying in or outside Egypt. In the event that no work is found of sufficient merit, an award shall not be made.

Obituaries

WILLIAM THORNWALL DAVIS, M.D.
1877–1944

William Thornwall Davis died at his home in Washington Friday, Feb. 16, 1944, at the age of 67. He went as he would probably have wished, suddenly, in the midst and at the peak of his brilliant, varied and fruitful career.



WILLIAM THORNWALL DAVIS, M.D.
1877–1944

Thornwall Davis (Bill to his intimates), of distinguished southern lineage, was born at Little Rock, Ark. By descent from an associate of George Rogers Clark, he held membership in the Society of the Cincinnati of Virginia. He was a nephew of Senator Blackburn of Kentucky and felt strong ties with that state, where he attended the Kentucky Military Institute. After receiving the degree of Doctor of Medicine from George Washington University and attending the United States Army Medical School, he began a notable career in the Army Medical Corps. This carried him through the Philippine campaign, where he served at one time under General Leonard Wood. Dr. Edmund Spaeth emphasizes the close contact that he maintained with the officers and with many enlisted men, especially those connected with the capture of Aguinaldo. In 1943 he was appointed consultant to the Surgeon General of the United States Army.

In 1906 and 1912 postgraduate work at the University of Vienna and at the Royal Ophthalmic Hospital in London led to his receiving a professorship of ophthalmology during World War I in the Army Medical School, with the rank of major, and later, in 1920, at George Washington University. Here he gained immediate eminence. Not only was he a competent clinician, much sought in a rapidly expanding community, but he was also a gifted teacher. Mrs. Davis writes: "In the teaching of his students he gave them more than knowledge.

He taught them love of service and integrity." His desire to reach a larger field in education brought about the inception of the famed George Washington University postgraduate course in ophthalmology. This was one of the earliest and most influential of the so-called refresher courses. Organized with the military precision characterizing Dr. Davis' enterprises, it operated with amazing smoothness. The quality of the curriculum and his ability to select and attract lecturers brought to the course as students leaders in the specialty from long distances and many states. A large proportion took the course year after year. Dr. Davis devised the unique plan of transcribing the lectures in the course to make them available for the students. This furnished a permanent record of original and valuable material and provided a useful and prized textbook.

One of the earlier oculists to appreciate the significance of orthoptic methods, he equipped his office elaborately both in apparatus and in personnel. He also made this a distinctive feature of the graduate course, continued after other activities had been curtailed by the war.

Well groomed, able, shrewed, civic minded, he served in numerous local organizations. He was senior surgeon at the Episcopal Eye and Ear Hospital, chief of service in ophthalmology at the George Washington University Hospital and consultant to other hospitals. He was a member of the Rotary Club, which granted him funds to establish an orthoptic clinic at the Episcopal Eye and Ear Hospital, and a director of the Washington Loan and Trust Company and of the Washington Society for the Prevention of Blindness.

He was convinced of the importance of medical meetings as an essential factor in professional training and was a regular attendant at such gatherings in all parts of the country. He contributed important papers, especially in the field of ocular motility, reporting investigations of the oblique muscles and orthoptics, and served in positions of influence. He was president of the Washington Ophthalmological Society, first vice president of the American Academy of Ophthalmology and Oto-Laryngology and chairman of the executive committee of the council of the Southern Medical Association. He frequently took part in the examination of candidates for the certificate of the American Board of Ophthalmology, and from his position in Washington he was a valued counsellor and supporter of the Board. He was honored by membership in a host of national and foreign military and professional organizations and in 1940 was decorated with the Order of Carlos J. Finlay. Ingenious and constructive in meeting the problems presented by the various enterprises with which he was connected, his advice and assistance will be missed by many students and colleagues.

In 1912 he married Renee Tolson, who shared with him in the gracious hospitality of their delightful home. She survives him, with four sons: Dr. William J. G. Davis, Cleveland; Major Roger Has Brouck Davis, Army Air Forces; First Lieutenant Rene S. Davis, United States Army, and Akin Thornwall Davis, a premedical student at George Washington University.

S. JUDD BEACH, M.D.

Book Reviews

The Principles and Practice of Ophthalmic Surgery. Third Edition. By Edmund B. Spaeth, M.D. Price, $11. Pp. 934, illustrated with 556 engravings, containing 798 figures and 6 colored plates. Philadelphia: Lea & Febiger, 1944.

In the third edition of this popular textbook on ophthalmic surgery one finds comparatively few changes. Most of the chapters have been altered little, if any. The section on muscles properly includes a discussion on the development of squint and its nonsurgical treatment. This chapter has largely been drawn from the writings of Travers and others who have made a special study of this subject. The author's great interest in ptosis is evidenced by the completeness with which this difficult problem has been covered. The section on intraocular foreign bodies has been largely rewritten, but it still leaves much to be desired. No mention is made of the bone-free method of localizing foreign bodies. There is a good discussion on the present day method of dealing with malignant growths in and about the eye; and although the reviewer is not ready as yet to accept the author's assertion that "under ordinary circumstances, malignancy about the eye . . . should be treated by radium therapy," the statement does portray the trend of the times. This well printed volume is replete with illustrations, most of which are excellently reproduced; but some are poor and meaningless. In spite of these minor criticisms, this textbook continues to fill an important place in ophthalmic literature. This edition has been reedited and revised; so its popularity is assured. It can be recommended to every ophthalmologist as a book of reference in which can be found definite advice on various surgical procedures.

JOHN H. DUNNINGTON.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e, France.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the Secretariat, 66 Boulevard Saint-Michel, Paris, 6e, France.

International Ophthalmologic Congress

President: Prof. Nordenson, Serafimerlasarettet, Stockholm, Sweden.
Secretary: Dr. Ehlers, Jerbanenegade 41, Copenhagen, Denmark.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 17 Horseferry Rd., London, England.

Pan-American Congress of Ophthalmology

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretaries: Dr. Conrad Berens, 35 E. 70th St., New York. Dr. M. E. Alvaro, 1511 Rua Consolacão, São Paulo, Brazil.

FOREIGN

All-India Ophthalmological Society

President: Dr. B. K. Narayan Rao, Minto Ophthalmic Hospital, Bangalore.
Secretary: Dr. G. Zachariah, Flitcham, Marshall's Rd., Madras.

British Medical Association, Section on Ophthalmology

President: Dr. W. Clark Souter, 9 Albyn Pl., Aberdeen, Scotland.
Secretary: Dr. Frederick Ridley, 12 Wimpole St., London, W. 1.

Chengtu Ophthalmological Society

President: Dr. Eugene Chan.
Secretary: Dr. K. S. Sun.
Place: Eye, Ear, Nose and Throat Hospital, Chengtu, China.

Chinese Ophthalmology Society

President: Dr. C. H. Chou, 363 Avenue Haig, Shanghai.
Secretary: Dr. F. S. Tsang, 221 Foochow Rd., Shanghai.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.

Hungarian Ophthalmological Society

President: Prof. I. Imre, Budapest.
Assistant Secretary: Dr. Stephen de Grósz, University Eye Hospital, Máriautca 39, Budapest.
All correspondence should be addressed to the Assistant Secretary.

Midland Ophthalmological Society

President: Dr. W. Niccol, 4 College Green, Gloucester, England.
Secretary: Mr. T. Harrison Butler, 61 Newhall St., Birmingham 3, England.
Place: Birmingham and Midland Eye Hospital.

North of England Ophthalmological Society

President: Mr. John Foster, 45 Park Sq., Leeds, England.
Secretary: Mr. William M. Muirhead, 70 Upper Hanover St., Sheffield, England.
Place: Manchester, Bradford, Leeds, Newcastle-upon-Tyne, Liverpool and Sheffield, in rotation. Time: October to April.

Ophthalmological Society of Australia

President: Dr. A. James Flynn, 135 Macquarie St., Sydney.
Secretary: Dr. D. Williams, 193 Macquarie St., Sydney.

Ophthalmological Society of Egypt

President: Prof. Dr. Mohammed Mahfouz Bey, Government Hospital, Alexandria.
Secretary: Dr. Mohammed Khalil, 4 Baehler St., Cairo.
All correspondence should be addressed to the secretary, Dr. Mohammed Khalil.

Ophthalmological Society of the United Kingdom

President: Mr. Charles B. Goulden, O.B.E., M.D., M.Ch., 89 Harley St., London, England.
Secretary: Mr. Frank W. Law, M.A., M.D., F.R.C.S., 30 Devonshire Pl., London W. 1, England.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Rd., Bombay 4, India.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14, India.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Oxford Ophthalmological Congress

Master: Mr. P. G. Doyne, 60 Queen Anne St., London, W. 1, England.
Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford, England. Time: July 8-9, 1943.

Palestine Ophthalmological Society

President: Dr. Arieh Feigenbaum, Abyssinian St. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel Aviv.

Polish Ophthalmological Society

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

Royal Society of Medicine, Section of Ophthalmology

President: Col. F. A. Juler, 96 Harley St., London, W. 1, England.
Secretary: Dr. Harold Ridley, 60 Queen Anne St., London, W. 1, England.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and keep it up to date.

São Paulo Society of Ophthalmology

President: Prof. Moacyr E. Alvaro, Consolação 1151, São Paulo, Brazil.

Secretary: Dr. Silvio de Almeida Toledo, Enfermaria Santa Luzia, Santa Casa de Misericordia, Cesario Motta, St. 112, São Paulo, Brazil.

Scottish Ophthalmological Club

President: Dr. S. Spence Meighan, 13 Woodside Pl., Glasgow, C. 3.

Secretary: Dr. Alexander Garrow, 15 Woodside Pl., Glasgow, C. 3.

Place: Edinburgh and Glasgow, in rotation.

Sociedad Argentina de Oftalmologia

Chairman: Dr. Jorge Malbrán, Buenos Aires.

Secretary: Dr. Benito Just Tiscornia, Santa Fe 1171, Buenos Aires.

Sociedad Oftalmologia del Litoral, Rosario (Argentina)

President: Prof. Dr. Carlos Weskamp, Laprida 1159, Rosario.

Secretary: Dr. Juan M. Vila Ortiz, Córdoba 1433, Rosario.

Place: Rosario. Time: Last Saturday of every month, April to November, inclusive. All correspondence should be addressed to the President.

Sociedade de Oftalmologia de Minas Gerais

President: Prof. Hilton Rocha, Rua Rio de Janeiro 2251, Belo Horizonte, Minas Gerais.

Secretary: Dr. Ennio Coscarelli, Rua Aimorés 1697, Belo Horizonte, Minas Gerais.

Sociedade de Oftalmologia e Otorrinolaringologia de Rio Grande do Sul

President: Dr. Luiz Assumpção Osorio, Edificio Vera Cruz, Apartamento 134, Porto Alegre, Rio Grande do Sul.

Secretary: Dr. Fernando Voges Alves, Caixa Postal 928, Porto Alegre, Rio Grande do Sul.

Sociedade de Ophthalmologia e Oto-Rhino-Laryngologia da Bahia

President: Dr. Theonilo Amorim, Barra Avenida, Bahia, Brazil.

Secretary: Dr. Adroaldo de Alencar, Brazil.

All correspondence should be addressed to the President.

Società Oftalmologica Italiana

President: Prof. Dott. Giuseppe Ovio, Ophthalmological Clinic, University of Rome, Rome.

Secretary: Prof. Dott. Epimaco Leonardi, Via del Gianicolo, 1, Rome.

Société Française d'Ophtalmologie

Secretary: Dr. René Onfray, 6 Avenue de la Motte Picquet, Paris, 7e.

Society of Swedish Ophthalmologists

President: Prof. K. G. Ploman, Stockholm.

Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö.

Tel Aviv Ophthalmological Society

President: Dr. D. Arieh-Friedman, 96 Allenby St., Tel Aviv, Palestine.

Secretary: Dr. Sadger Max, 9 Bialik St., Tel Aviv, Palestine.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Frederick C. Cordes, 384 Post St., San Francisco.

Secretary: Dr. R. J. Masters, 23 E. Ohio St., Indianapolis.

American Academy of Ophthalmology and Otolaryngology, Section on Ophthalmology

President: Dr. Lawrence T. Post, Metropolitan Bldg., St. Louis.

President-Elect: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.

Executive Secretary-Treasurer: Dr. William L. Benedict, 101–1st Ave. Bldg., Rochester, Minn.

American Ophthalmological Society

President: Dr. S. Judd Beach, 704 Congress St., Portland, Maine.

Secretary-Treasurer: Dr. Walter S. Atkinson, 129 Clinton St., Watertown, N. Y.

Association for Research in Ophthalmology, Inc.

Chairman: Dr. Conrad Berens, 35 E. 70th St., New York.

Secretary-Treasurer: Major Brittain F. Payne, School of Aviation Medicine, Randolph Field, Texas.

Assistant Secretary-Treasurer: Dr. Hunter Romaine, 35 E. 70th St., New York.

Canadian Medical Association, Section on Ophthalmology

President: Dr. Alexander E. MacDonald, 170 St. George St., Toronto.

Secretary-Treasurer: Dr. L. J. Sebert, 170 St. George St., Toronto.

Canadian Ophthalmological Society

President: Dr. R. Evatt Mathers, 34½ Morris St., Halifax, N. S.

Secretary-Treasurer: Dr. Kenneth B. Johnston, Suite 1, 1509 Sherbrooke St. W., Montreal.

National Society for the Prevention of Blindness

President: Mr. Mason H. Bigelow, 1790 Broadway, New York.

Secretary: Miss Regina E. Schneider, 1790 Broadway, New York.

Executive Director: Mrs. Eleanor Brown Merrill, 1790 Broadway, New York.

SECTIONAL

Academy of Medicine of Northern New Jersey, Section on Eye, Ear, Nose and Throat

President: Dr. N. Zwaifler, 46 Wilbur Ave., Newark.

Secretary: Dr. William F. Keim Jr., 25 Roseville Ave., Newark.

Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Central Wisconsin Society of Ophthalmology and Otolaryngology

President: Dr. L. J. Friend, 425 E. Grand Ave., Beloit, Wis.

Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Paul A. Chandler, 5 Bay State Rd., Boston.
Secretary-Treasurer: Dr. Merrill J. King, 264 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. D. H. O'Rourke, 1612 Tremont Pl., Denver.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. L. L. Bull, 1215–14th Ave., Seattle, Wash.
Secretary-Treasurer: Dr. Barton E. Peden, 301 Stimson Bldg., Seattle 1.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. Sheldon Clark, 27 E. Stephenson St., Freeport, Ill.
Secretary-Treasurer: Dr. Harry R. Warner, 321 W. State St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month from October to April, inclusive.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. M. H. Pike, Midland, Mich.
Secretary-Treasurer: Dr. H. H. Heuser, 207 Devidson Bldg., Bay City, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July, August and September.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. C. Decker, 515 Francis Bldg., Sioux City, Iowa.
Secretary-Treasurer: Dr. J. E. Dvorak, 408 Davidson Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. John H. Burleson, 414 Navarro St., San Antonio, Texas.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville, S. C.

SOUTHWESTERN ACADEMY OF EYE, EAR, NOSE AND THROAT

President: Dr. H. L. Brehmer, 221 W. Central Ave., Albuquerque, N. Mex.
Secretary: Dr. A. E. Cruthirds, 1011 Professional Bldg., Phoenix, Ariz.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. W. M. Dodge, 716 First National Bank Bldg., Battle Creek.
Secretary-Treasurer: Dr. Kenneth Lowe, 25 W. Michigan Ave., Battle Creek.
Time: Last Thursday of September, October, November, March, April and May.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Ray Parker, 218 Franklin St., Johnston, Pa.
Secretary-Treasurer: Dr. J. McClure Tyson, Deposit Nat'l Bank Bldg., DuBois.

STATE

ARKANSAS STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. Raymond C. Cook, 701 Main St., Little Rock.
Secretary: Dr. K. W. Cosgrove, Urquhart Bldg., Little Rock.

COLORADO OPHTHALMOLOGICAL SOCIETY

President: Dr. C. A. Ringle, 912–9th Ave., Greeley.
Secretary: Dr. W. A. Ohmart, 1102 Republic Bldg., Denver.
Place: University Club, Denver. Time: 7:30 p. m., third Saturday of each month, October to May, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. F. L. Phillips, 405 Temple St., New Haven.
Secretary-Treasurer: Dr. W. H. Turnley, 1 Atlantic St., Stamford, Conn.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA

President: William O. Martin Jr., Doctors Bldg., Atlanta.
Secretary-Treasurer: Dr. C. K. McLaughlin, 526 Walton St., Macon.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. F. McK. Ruby, Union City.
Secretary: Dr. Edwin W. Dyar Jr., 23 E. Ohio St., Indianapolis.
Place: French Lick. Time: First Wednesday in April.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. J. K. Von Lackum, 117–3d St. S. E., Cedar Rapids.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.

KANSAS STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. D. Pittman, Pratt.
Secretary: Dr. Louis R. Haas, 902 N. Broadway, Pittsburg.

LOUISIANA-MISSISSIPPI OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. Val H. Fuchs, 200 Carondelet St., New Orleans.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Robert H. Fraser, 25 W. Michigan Ave., Battle Creek.
Secretary: Dr. R. G. Laird, 114 Fulton St., Grand Rapids.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Secretary: Dr. William A. Kennedy, 372 St. Peter St., St. Paul.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. William Morrison, 208 N. Broadway, Billings, Mont.
Secretary: Dr. Fritz D. Hurd, 309 Medical Arts Bldg., Great Falls.

Nebraska Academy of Ophthalmology and Otolaryngology

President: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Secretary-Treasurer: Dr. John Peterson, 1307 N St., Lincoln.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr B. E. Failing, 31 Lincoln Park, Newark.
Secretary: Dr. George Meyer, 410 Haddon Ave., Camden.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Harold J. Joy, 504 State Tower Bldg., Syracuse 2.
Secretary: Dr. Maxwell D. Ryan, 660 Madison Ave., New York 21.

North Carolina Eye, Ear, Nose and Throat Society

President: Dr. Hugh C. Wolfe, 102 N. Elm St., Greensboro.
Secretary: Dr. Vanderbilt F. Couch, 104 W. 4th St., Winston-Salem.

North Dakota Academy of Ophthalmology and Oto-Laryngology

President: Dr. W. L. Diven, City National Bank Bldg., Bismarck.
Secretary-Treasurer: Dr. A. E. Spear, 20 W. Villard, Dickenson.

Oregon Academy of Ophthalmology and Oto-Laryngology

President: Dr. Paul Neely, 1020 S. W. Taylor St., Portland.
Secretary-Treasurer: Dr. Lewis Jordon, 1020 S. W. Taylor St., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

Pennsylvania Academy of Ophthalmology and Otolaryngology

President: Dr. Lewis T. Buckman, 83 S. Franklin St., Wilkes-Barre.
Secretary Pro Tem: Dr. Paul C. Craig, 232 N. 5th St., Reading.
Time: Last week in April.

Rhode Island Ophthalmological and Otological Society

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

South Carolina Society of Ophthalmology and Otolaryngology

President: Dr. J. L. Sanders, 222 N. Main St., Greenville.
Secretary: Dr. J. H. Stokes, 125 W. Cheves St., Florence.

Tennessee Academy of Ophthalmology and Otolaryngology

President: Dr. Wesley Wilkerson, 700 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 124 Physicians and Surgeons Bldg., Memphis.

Texas Ophthalmological and Oto-Laryngological Society

President: Dr. F. H. Rosebrough, 603 Navarro St., San Antonio.
Secretary: Dr. M. K. McCullough, 1717 Pacific Ave., Dallas.

Utah Ophthalmological Society

President: Dr. R. B. Maw, 699 E. South Temple, Salt Lake City.
Secretary-Treasurer: Dr. Charles Ruggeri Jr., 1120 Boston Bldg., Salt Lake City.
Place: University Club, Salt Lake City. Time: 7:00 p. m., third Monday of each month.

Virginia Society of Oto-Laryngology and Ophthalmology

President: Dr. Mortimer H. Williams, 30½ Franklin Rd. S. W., Roanoke.
Secretary-Treasurer: Dr. Meade Edmunds, 34 Franklin St., Petersburg.

West Virginia State Medical Association, Eye, Ear, Nose and Throat Section

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. E. L. Mather, 39 S. Main St., Akron, Ohio.
Secretary-Treasurer: Dr. V. C. Malloy, 2d National Bank Bldg., Akron, Ohio.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. B. M. Cline, 153 Peachtree St. N. E., Atlanta, Ga.
Acting Secretary: Dr. A. V. Hallum, 478 Peachtree St. N. E., Atlanta, Ga.
Place: Grady Hospital. Time: 6:00 p. m., fourth Monday of each month, from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Ernst Bodenheimer, 1212 Eutaw Pl., Baltimore.
Secretary: Dr. Thomas R. O'Rourk, 104 W. Madison St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to March.

Birmingham Eye, Ear, Nose and Throat Club

President: Each member, in alphabetical order.
Secretary: Dr. Luther E. Wilson, 919 Woodward Bldg., Birmingham, Ala.
Place: Tutwiler Hotel. Time: 6:30 p. m., second Tuesday of each month, September to May, inclusive.

Brooklyn Ophthalmological Society

President: Dr. Michael J. Buonaguro, 589 Lorimer St., Brooklyn.
Secretary-Treasurer: Dr. Benjamin C. Rosenthal, 140 New York Ave., Brooklyn 16.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Walter F. King, 519 Delaware Ave., Buffalo.
Secretary-Treasurer: Dr. Sheldon B. Freeman, 196 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. Douglas Chamberlain, Chattanooga Bank Bldg., Chattanooga, Tenn.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Vernon M. Leech, 55 E. Washington St., Chicago.
Secretary: Dr. W. A. Mann, 30 N. Michigan Ave., Chicago.
Place: Chicago Towers Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati General Hospital Ophthalmology Staff

Chairman: Dr. D. T. Vail, 441 Vine St., Cincinnati.
Secretary: Dr. A. A. Levin, 441 Vine St., Cincinnati.
Place: Cincinnati General Hospital. Time: 7:45 p. m., third Friday of each month except June, July and August.

Cleveland Ophthalmological Club

Chairman: Dr. Shandor Monson, 1621 Euclid Ave., Cleveland.
Secretary: Dr. Carl Ellenberger, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. W. S. Reese, 1901 Walnut St., Philadelphia.
Clerk: Dr. George F. J. Kelly, 37 S. 20th St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. H. D. Emswiler, 370 E. Town St., Columbus, Ohio.
Secretary-Treasurer: Dr. D. G. Sanor, 206 E. State St., Columbus, Ohio.
Place: The Neil House. Time: 6 p. m., first Monday of each month.

Corpus Christi Eye, Ear, Nose and Throat Society

Chairman: Dr. Arthur Padillo, 414 Medical Professional Bldg., Corpus Christi, Texas.
Secretary: Dr. Edgar G. Mathis, 815 Medical Arts Bldg., Corpus Christi, Texas.
Time: Second Friday of each month from October to May.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. Ruby K. Daniel, Medical Arts Bldg., Dallas 1, Texas.
Secretary: Dr. Tom Barr, Medical Arts Bldg., Dallas 1, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. H. C. Schmitz, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Byron M. Merkel, 604 Locust St., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Cecil W. Lepard, 1025 David Whitney Bldg., Detroit.
Place: Club rooms of Wayne County Medical Society.
Time: First Wednesday of each month, November through April.

Detroit Ophthalmological Society

President: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. Leland F. Carter, 1553 Woodward Ave., Detroit.
Place: Club rooms of Wayne County Medical Society. Time: Third Thursday of each month from November to April, inclusive.

Eastern New York Eye, Ear, Nose and Throat Association

President: Appointed at each meeting.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. Rex Howard, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. R. H. Gough, Medical Arts Bldg., Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Houston Academy of Medicine, Ophthalmological and Oto-Laryngological Section

President: Dr. Lyle J. Logue, 1304 Walker Ave., Houston, Texas.
Secretary: Dr. John T. Stough, 803 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Oto-laryngological Society

President: Dr. Myron Harding, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: Indianapolis Athletic Club. Time: 6:30 p. m., second Thursday of each month from November to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Edgar Johnson, 906 Grand Ave., Kansas City, Mo.
Secretary: Dr. W. E. Keith, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Harold Snow, 614 S. Pacific Ave., San Pedro, Calif.
Secretary-Treasurer: Dr. Oliver R. Nees, 508 Times Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Otolaryngology

President: Dr. M. E. Trainor, 523 W. 6th St., Los Angeles.
Secretary-Treasurer: Dr. Orrie E. Ghrist, 210 N. Central Ave., Glendale, Calif.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:00 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye and Ear Society

President: Dr. Joseph S. Heitger, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. J. W. Fish, 321 W. Broadway, Louisville, Ky.
Place: Brown Hotel. Time. 6:30 p. m., second Thursday of each month from September to May, inclusive.

Lower Anthracite Eye, Ear, Nose and Throat Society

Chairman: Each member in alphabetical order.
Secretary: Dr. James J. Monohan, 31 S. Jardin St., Shenandoah, Pa.

Medical Society of the District of Columbia, Section of Ophthalmology and Otolaryngology

Chairman: Dr. P. S. Constantinople, 1835 I St. N. W., Washington.
Secretary: Dr. Frazier Williams, 1801 I St. N. W., Washington.
Place: 1718 M St. N. W. Time: 8 p.m., third Friday of each month from October to April, inclusive.

Memphis Society of Ophthalmology and Otolaryngology

Chairman: Each member in alphabetical order.
Secretary: Dr. Sam H. Sanders, 1089 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p.m., second Tuesday of each month from September to May.

Milwaukee Oto-Ophthalmic Society

President: Dr. Edwin C. Bach, 324 E. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Ralph T. Rank, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

Montgomery County Medical Society

Chairman: Dr. H. V. Dutrow, 1040 Fidelity Medical Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Maitland D. Place, 981 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., first Tuesday of each month from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. J. Rosenbaum, 1396 Ste. Catherine St. W., Montreal, Canada.
Secretary: Dr. L. Tessier, 1230 St. Joseph Blvd. E., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. M. M. Cullom, 700 Church St., Nashville, Tenn.
Secretary: Dr. R. E. Sullivan, 432 Doctors Bldg., Nashvile, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May

New Haven Ophthalmological Society

President: Dr. William H. Ryder, 185 Church St., New Haven, Conn.
Secretary: Dr. Frederick A. Wiess, 255 Bradley St., New Haven, Conn.

New Orleans Ophthalmological and Oto-laryngological Society

President: Dr. W. B. Clark, 1012 American Bank Bldg., New Orleans.
Secretary: Dr. Mercer G. Lynch, 1018 Maison Blanche Bldg., New Orleans.
Place: Louisiana State University Medical Bldg. Time: 8 p. m., second Tuesday of each month from October to May.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. Frank C. Keil, 660 Madison Ave., New York.
Secretary: Dr. Willis S. Knighton, 121 E. 61st St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Milton Berliner, 57 W. 57th St., New York.
Secretary: Dr. Benjamin Esterman, 983 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 8 p. m., first Monday of each month from October to May, inclusive.

Oklahoma City Academy of Ophthalmology and Otolaryngology

President: Dr. James P. Luton, 117 N. Broadway, Oklahoma City.
Secretary: Dr. Harvey O. Randel, 117 N. Broadway, Oklahoma City.
Place: University Hospital. Time: Second Tuesday of each month from September to May.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. D. D. Stonecypher, Nebraska City, Neb.
Secretary-Treasurer: Dr. W. Howard Morrison, 1500 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m. dinner; 7 p. m. program; third Wednesday of each month from October to May.

Passaic-Bergen Ophthalmological Club

President: Dr. Thomas Sanfacon, 340 Park Ave., Paterson, N. J.
Secretary-Treasurer: Dr. J. Averbach, 435 Clinton Ave., Clinton, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

President: Dr. Isaac Tassman, 136 S. 16th St., Philadelphia.
Secretary: Dr. Glen Gregory Gibson, 255 S. 17th St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. George H. Shuman, 351-5th Ave., Pittsburgh.
Secretary: Dr. Robert J. Billings, 509 Liberty Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Reading Eye, Ear, Nose and Throat Society

President: Dr. Michael J. Penta, 312 N. 5th St., Reading, Pa.
Secretary: Dr. Paul C. Craig, 232 N. 5th St., Reading, Pa.
Place: Wyomissing Club. Time: 6:30 p. m., third Wednesday of each month from September to July.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. Peter N. Pastore, Medical College of Virginia, Richmond, Va.
Secretary: Dr. Clifford A. Folkes, Professional Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

Rochester Eye, Ear, Nose and Throat Society

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Charles T. Sullivan, 277 Alexander St., Rochester, N. Y.

St. Louis Ophthalmic Society

President: Dr. C. C. Beisbarth, 3720 Washington Blvd., St. Louis.
Secretary: Dr. H. R. Hildreth, 508 N. Grand Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting, 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

San Antonio Ophthalmo-Oto-Laryngological Society

President: Dr. Belvin Pritchett, 705 E. Houston St., San Antonio 5, Texas.
Secretary-Treasurer: Lt. Col. John L. Matthews, AAF School of Aviation Medicine, Randolph Field, Texas.
Place: San Antonio, Brooke General Hospital, Randolph Field or San Antonio Aviation Cadet Center. Time: 7 p. m., second Tuesday of each month from October to May.

San Francisco County Medical Society, Section on Eye, Ear, Nose and Throat

Chairman: Dr. Roy H. Parkinson, 870 Market St., San Francisco.
Secretary: Dr. A. G. Rawlins, 384 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except June, July and December.

Shreveport Eye, Ear, Nose and Throat Society

President: Dr. David C. Swearingen, Slattery Bldg., Shreveport, La.
Secretary-Treasurer: Dr. Kenneth Jones, Medical Arts Bldg., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

Spokane Academy of Ophthalmology and Oto-Laryngology

President: Dr. Clarence A. Veasey Sr., 421 W. Riverside Ave., Spokane, Wash.
Secretary: Dr. Clarence A. Veasey Jr., 421 W. Riverside Ave., Spokane, Wash.
Place: Spokane Medical Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

Syracuse Eye, Ear, Nose and Throat Society

President: Dr. A. H. Rubenstein, 713 E. Genesee St., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. H. Blaisdell, 713 E. Genesee St., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

Toledo Eye, Ear, Nose and Throat Society

Chairman: Dr. E. W. Campbell, 316 Michigan St., Toledo, Ohio.
Secretary: Dr. L. C. Ravin, 316 Michigan St., Toledo, Ohio.
Place: Toledo Club. Time: Each month except June, July and August.

Toronto Academy of Medicine, Section of Ophthalmology

Chairman: Dr. W. R. F. Luke, 316 Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. T. Gratton, 216 Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queens Park. Time: First Monday of each month, November to April.

Washington, D. C., Ophthalmological Society

President: Dr. S. Bockoven, 1752 Massachusetts Ave., Washington, D. C.
Secretary-Treasurer: Dr. John Lloyd, 1218–16th St. N. W., Washington, D. C.
Place: Medical Society of District of Columbia Bldg., 1718 M St. N. W., Washington, D. C. Time: 7:30 p. m., first Monday in November, January, March and May.

Wilkes-Barre Ophthalmological Society

Chairman: Each member in turn.
Secretary: Dr. Samuel T. Buckman, 70 S. Franklin St., Wilkes-Barre, Pa.
Place: Office of chairman. Time: Last Tuesday of each month from October to May.